

UNT Discovery Park D170 Fit-Out

Project Manual – Issue for Construction



Treanor Project #: HE0569.2402

Date: April 1, 2025

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Section 00 0107
PROFESSIONAL CERTIFICATIONS

PROFESSIONAL CERTIFICATIONS – ARCHITECTURAL

The following Drawings and Technical Specifications have been prepared under the direction of the following professionals. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

Drawings: G-series, AD-series, and A-series.

Specification Sections: Divisions 01, 02 ,05 ,06, 07, 08, 09, 10, and 12.



04.01.2025

Treanor

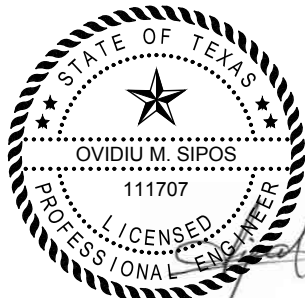
2554 Elm Street, Suite 200
Dallas, Texas 75226-1497
214.310.1018

PROFESSIONAL CERTIFICATIONS – CIVIL, STRUCTURAL

The following Drawings and Technical Specifications have been prepared under the direction of the following professionals. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

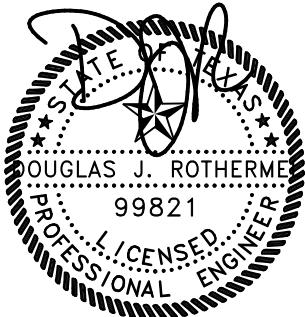
Drawings: C-series, S-series.

Specification Sections: Divisions 3, 5.



04-01-2025

4/1/25



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3017 W 7th Street, Suite 400
Fort Worth, TX 76107
214.752.9098

PROFESSIONAL CERTIFICATIONS – MECHANICAL, ELECTRICAL, PLUMBING

The following Drawings and Technical Specifications have been prepared under the direction of the following professionals. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

Drawings: M-series, P-series, and E-series.

Specification Sections: Divisions 21, 22, 23, 26, 28.

Tx. Registration # F-20213



Tx. Registration # F-20213



Tx. Registration # F-20213



Gonzalez Shah Smith, Inc. (GSS)

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Dallas, Texas 75063
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END OF SECTION

DOCUMENT 003132

GEOTECHNICAL DATA

- 1.1 SUMMARY
 - A. This document includes information pertaining to geotechnical data.
- 1.2 INVESTIGATION
 - A. An investigation of subsurface soil conditions at the building site was authorized by the Owner, and was subsequently performed by **UES**, project number **W243611-rev1**, dated **February 19, 2024**.
- 1.3 REPORT
 - A. The Geotechnical Investigation Report is for information only and is not a warranty of subsurface conditions.
 - B. The Report is made available for information only.
 - C. The information contained in the Report represents design criteria, recommendations, and guidelines that were utilized as the basis of design for the engineering of the earthwork operations, paving design, and foundation design indicated in the Contract Documents. No changes in these design criteria will be considered or permitted.
- 1.4 RESPONSIBILITY
 - A. Bidders are expected to examine the site and subsurface investigation reports.
 - B. The Design Professional and Owner assume no responsibility for variations in subsoil conditions, quality, or stability, or for the presence, level, and extent of underground water.
 - C. The Design Professional and Owner assume no responsibility for Bidder's interpretation of data contained in the Report.

END OF DOCUMENT

SECTION 011000

SUMMARY OF WORK

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. Owner-furnished products
 - 6. Access to site
 - 7. Coordination with occupants
 - 8. Work restrictions
 - 9. Specification and drawing conventions
 - 10. Special provisions
 - 11. Purpose of Division 1 – General Requirements
- 1.3 PROJECT INFORMATION
 - A. Owner: University of North Texas System
 - B. Project Identification: 3594-14728
 - C. Project Location: Discovery Park D170
 - 1. Owner's Construction Manager
 - 2. Owner's Designated Representative
 - D. Architect: Treanor
 - E. Project Web Site: A Project Web site administered by the Contractor will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Division 01 Section 013100 "Project Management and Coordination" for Contractor's requirements for utilizing the Project Web site.
- 1.4 WORK COVERED BY CONTRACT DOCUMENTS
 - A. The Work of the Project is defined by the Contract Documents and consists of the following:
 - 1. Design and construction administration services for the partial remodel of Discovery Park D170. Scope includes architectural design, laboratory planning, structural engineering, civil engineering, rough-in for technology systems, mechanical, electrical, plumbing and fire protection engineering, and cost consulting.
 - B. Type of Contract
 - 1. Project will be constructed under a CSP contract.
- 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.
 - B. Fees Paid by Owner: Impact Fees.
 - C. Fees Reimbursed by Owner: Tap Fees and Meter Fees.

1.6 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to [work in areas] [areas within the Contract limits] indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated. Use of any area outside of work area must be approved by Owner.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather-tight condition throughout construction period. Repair damage caused by construction operations to equal or better condition.

1.7 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than three (3) day notice to Owner of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, except as otherwise indicated.
 - 1. Hours for Utility Shutdowns: Coordinated with Owner, with not less than two (2) weeks written notice of intended shutdown.
 - 2. Hours for core drilling and other noisy activities: Coordinated with Owner
- C. 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 three (3) days in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Owner not less than three (3) days in advance of proposed disruptive operations.
 - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Nonsmoking Campus: Smoking is not permitted anywhere on any UNT campus.
- F. Employee Identification: Provide identification tags for Contractor personnel working on the Project site. Require personnel to utilize identification tags at all times.

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 the Drawings are described in detail in the Specifications. One or more of the following are used on the 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.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.10 SPECIAL PROVISIONS

- A. Review Owner's tree protection and mitigation policy (Denton Campus ONLY) available at <http://policy.unt.edu/policy/8-6>.
Review Owner's Campus Design Guidelines (Denton ONLY) available at https://facilities.unt.edu/sites/default/files/DESIGN%20GUIDELINES%202017_rev%203_09.01.17.pdf

1.11 DIVISION 1 – GENERAL REQUIREMENTS

- A. The specification sections contained with Division 01 – General Requirements, serve to expand and define in more detail, the administrative and procedural requirements outlined in Section 007000 – General Conditions. Should any provisions with Division 01 sections be in conflict with the General Conditions, the General Conditions shall govern.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 012100
ALLOWANCES

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 governing allowances.
1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
1. Lump sum allowances
2. Unit cost allowances
3. Quantity allowances
- 1.3 SELECTION AND PURCHASE
- A. At the earliest practical date after award of the Contract, advise Design Professional and Owner of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Design Professional's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Design Professional from the designated supplier.
- 1.4 SUBMITTALS
- A. Submit proposals for purchase of products or systems included in allowances.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.
- 1.5 COORDINATION
- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.
- 1.6 LUMP SUM, UNIT COST AND QUANTITY ALLOWANCES
- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Design Professional under allowance and shall include freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials [ordered by Owner] [selected by Architect] under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
1. If requested by Design Professional, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.
- 1.7 ADJUSTMENT OF ALLOWANCES
- A. Allowance Adjustment: Should Owner determine that an adjustment is needed in an allowance amount; a Change Order will be prepared based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit cost allowances.
 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

- 3.1 EXAMINATION
- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.
- 3.2 PREPARATION
- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.
- 3.3 SCHEDULE OF ALLOWANCES
- A. Allowance No. [] : Lump Sum Unit Cost Quantity Contingency Testing and Inspecting Allowance: Include the sum of [Insert dollar or quantity amount of allowance] : Include [Insert allowance description] as specified in Division [Insert Division number] Section "[Insert Section title]" and as shown on Drawings.
1. This allowance includes material cost, receiving, handling, and installation, and Contractor overhead and profit .
 2. Coordinate quantity allowance adjustment with corresponding unit price requirements of Division 01 Section "Unit Prices."

END OF SECTION

SECTION 012200

UNIT PRICES

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 unit prices.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, cost for delivery, installation, insurance, overhead, and profit.
- B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1 – Movable Metal Lab Casework.
 - 1. Description: Movable Metal Lab Casework according to Division 12 3553 Section 2, "MOVEABLE LABORATORY CASEWORK SYSTEM".
 - 2. Unit of Measurement: Movable bench (each) and mobile base cabinets (each).
 - 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section 012100, "Allowances".

END OF SECTION

SECTION 012300
ALTERNATES

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 alternates.
- 1.3 DEFINITIONS
- A. Alternate: An amount proposed by Contractor and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
- 1.4 PROCEDURES
- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

- 3.1 SCHEDULE OF ALTERNATES
- A. **Alternate No. 1:** Full build-out of Wet Lab Support room on Level 1 (D173 WET SUPPORT), containing (1) floor-mounted chemical fume hood. Refer to sheet A811A. Sink, fixed casework, and mechanical, electrical, and plumbing infrastructure to support future build-out of D173 WET SUPPORT is considered Base Bid.
- B. **Alternate No. 2:** (2) additional chemical fume hoods with fixed lab casework in D270 WET LAB, for a total of (4) chemical fume hoods on Level 2. Refer to sheet A812A.
- C. **Alternate No. 3:** Full furnishing of movable metal laboratory casework on Level 1 and Level 2 as specified in Specification Section 12 3553. Refer to sheets A811A and A812A.
- D. **Alternate No. 4:** Full build-out of Autoclave room on Level 2 (D271 AUTOCLAVE) containing (1) stainless steel scullery sink, an autoclave, and an undercounter glass washer. Refer to sheet A812A. Mechanical, electrical, and plumbing infrastructure to support future build-out in room D271 is considered Base Bid.

END OF SECTION

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.

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 or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 SUBMITTALS

- A. Substitution Requests: Submit one (1) PDF file 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 CSI Form 012500.13
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product, fabrication, or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution 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 and 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 substitution 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. Design Professional's Action: If necessary, Design Professional will request additional information or documentation for evaluation within seven (7) days of receipt of a request for substitution. Design Professional will notify Contractor of acceptance or rejection of proposed substitution within fifteen (15) days of receipt of request, or seven (7) 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 qualified testing agency to perform compatibility tests recommended by manufacturers.
- 1.6 PROCEDURES
 - A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

- 2.1 SUBSTITUTIONS
 - A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Design Professional 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.
 - B. Substitutions for Convenience: Not allowed, unless otherwise indicated. If allowed Design Professional will consider requests for substitution if received within sixty (60) days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Design Professional.
 - 1. Conditions: Design Professional will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Design Professional will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect Design Professional redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.

- j. 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 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 012500.13
SUBSTITUTION REQUEST FORM

PROJECT: _____ (After Contract Award)

TO: _____

NO. _____ DATE: _____

Contractor hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Division 01 Section 012500 "Substitution Procedures":

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _____

Specification Section No.: _____ Article/ Paragraph: _____

2. REASON FOR SUBSTITUTION REQUEST

SPECIFIED PRODUCT

- ☐ Is no longer available
- ☐ Is unable to meet project schedule
- ☐ Is unsuitable for the designated application
- ☐ Cannot interface with adjacent materials
- ☐ Is not compatible with adjacent materials
- ☐ Cannot provide the specified warranty
- ☐ Cannot be constructed as indicated

PROPOSED PRODUCT

- ☐ Will reduce construction time
- ☐ Will result in cost savings of \$ _____ to Project
- ☐ Is for supplier's convenience
- ☐ Is for subcontractor's convenience
- ☐ Other: _____

☐ Cannot be obtained due to one or more of the following:

- ☐ Strike
- ☐ Bankruptcy of manufacturer or supplier
- ☐ Lockout
- ☐ Similar occurrence (explain below)

3. SUPPORTING DATA

- ☐ Drawings, specifications, product data, performance data, test data, and any other necessary information to facilitate review of the Substitution Request are attached.
- ☐ Sample is attached
- ☐ Sample will be sent if requested

4. QUALITY COMPARISON

Provide all necessary side-by-side comparative data as required to facilitate review of Substitution Request:

SPECIFIED PRODUCT

PROPOSED PRODUCT

Manufacturer: _____

Name / Brand: _____

Catalog No.: _____

Vendor: _____

Variations: _____

(Add Additional Sheets If Necessary)

Local Distributor or Supplier: _____

Maintenance Service Available: ☐ Yes ☐ No

Spare Parts Source: _____

Warranty: ☐ Yes ☐ No _____ Years

5. PREVIOUS INSTALLATIONS

Identification of at least three (3) similar projects on which proposed substitution was used:

PROJECT #1

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #2

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #3

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

6. EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades: ☐ No ☐ Yes (if yes, explain)

Proposed substitution requires dimensional revisions or redesign of architectural, structural, M-E-P, life safety, or other work:

☐ No ☐ Yes (if yes, attach data explaining revisions)

7. STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS

Contractor and Subcontractor have investigated the proposed substitution and hereby represent that:

- A. They have personally investigated the proposed substitution and believe that it is equal to or superior in all respects to specified product, except as stated above;
- B. The proposed substitution is in compliance with applicable codes and ordinances;
- C. The proposed substitution will provide same warranty as specified for specified product;
- D. They will coordinate the incorporation of the proposed substitution into the Work, and will include modifications to the Work as required to fully integrate the substitution;
- E. They have included complete cost data and implications of the substitution (attached);
- F. They will pay any redesign fees incurred by the Architect or any of the Design Professional's consultants, and any special inspection costs incurred by the Owner, caused by the use of this product;
- G. They waive all future claims for added cost or time to the Contract related to the substitution, or that become known after substitution is accepted.
- H. The Design Professional's approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Design Professional at the time decision is rendered and Addendum is issued; and that Design Professional's approval therefore is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Contractor: _____
(Name of Contractor)

Date: _____ By: _____

Subcontractor: _____
(Name of Subcontractor)

Date: _____ By: _____

Note: Unresponsive or incomplete requests will be rejected and returned without review.

8. DESIGN PROFESSIONAL'S REVIEW AND ACTION

- ☐ Substitution is accepted.
- ☐ Substitution is accepted, with the following comments: _____

-
- ☐ Resubmit Substitution Request:
- ☐ Provide more information in the following areas: _____
- _____
- _____
- ☐ Provide proposal indicating amount of savings / credit to Owner
- ☐ Bidding Contractor shall sign Bidder's Statement of Conformance
- ☐ Bidding Subcontractor shall sign Bidder's Statement of Conformance
- ☐ Substitution is not accepted:
- ☐ Substitution Request received too late.
- ☐ Substitution Request received directly from subcontractor or supplier.
- ☐ Substitution Request not submitted in accordance with requirements.
- ☐ Substitution Request Form is not properly executed.
- ☐ Substitution Request does not indicate what item is being proposed.
- ☐ Insufficient information submitted to facilitate proper evaluation.
- ☐ Proposed product does not appear to comply with specified requirements.
- ☐ Proposed product will require substantial revisions to Contract Documents.

By: _____

Date: _____

Design Professional has relied upon the information provided by the Contractor, and makes no claim as to the accuracy, completeness, or validity of such information. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall provide the specified product.

9. OWNER'S REVIEW AND ACTION

- ☐ Substitution is accepted for items not involving additional costs.
- ☐ Substitution is not accepted.

By: _____
(Owner's Construction Manager)

Date: _____

END OF FORM

SECTION 012600
CONTRACT MODIFICATION 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 handling and processing Contract modifications.
 - B. Related Sections:
 - 1. Division 01 Section 016000, "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.
- 1.3 MINOR CHANGES IN THE WORK
 - A. Design Professional 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, "Architect's Supplemental Instructions." or Architect's Bulletin form.
- 1.4 CHANGE ORDER REQUESTS
 - A. Owner/Design Professional-Initiated Change Order Requests: 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. Change Order Requests issued by Owner/Design Professional are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Change Order Request after receipt of Change Order 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.
 - e. Quotation Form: Use Change Order Request (COR) form. Contractor shall complete the COR Cost Analysis form and the Sub-Contractor shall submit the Sub-Contractor Cost Analysis form with supporting documentation and cost breakdown by line item, or other form approved by Owner.
 - B. Contractor-Initiated Change Orders: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Owner/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 Division 01 Section 012500, "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 - 7. Change Order Request Form: Use Owner's standard Change Order Request form as approved by Owner and Design Professional.

- 1.5 ADMINISTRATIVE CHANGE ORDERS
 - A. Allowance Adjustment: Refer to Division 01, Section 012100, "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
 - B. Unit Price Adjustment: Refer to Division 01 Section 012200, "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit price work.
- 1.6 CHANGE ORDER PROCEDURES
 - A. On Owner's approval of a Change Order Request, Owner will prepare and issue a Change Order on attached form for signatures of Owner, Design Professional and Contractor.
- 1.7 CONSTRUCTION CHANGE DIRECTIVE
 - A. Work Change Directive: Owner may issue a Construction Change Directive on attached form. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
 - B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

UNT | SYSTEM™

PROJECT NAME:

Total	\$	-
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NOT VALID UNTIL SIGNED BY THE A/E, CONTRACTOR AND OWNER

Date _____

Construction Change Directive



FROM OWNER:
University of North Texas (System or Institution)
1155 Union Circle #311040
Denton, Texas 76203

CONSTRUCTION CHANGE DIRECTIVE NUMBER: _____

DATE ISSUED: _____

TO CONTRACTOR: *(Name and Address)*

PROJECT NAME: _____
AGREEMENT DATE: _____
CIP PROJECT NUMBER: _____
PURCHASE ORDER NUMBER: _____

The following change in the Contract Documents is approved by the Owner and the Work is authorized to proceed accordingly:

Additional Days Required <input style="width: 50px;" type="text"/> Calendar Days	Not to Exceed Cost \$ <input style="width: 100px;" type="text"/> -
--	--

When the Owner and Contractor agree upon the exact adjustment in the Contract Price and/or the Contract Time for a change in the Work directed by this Construction Change Directive, such agreement shall be the subject of a Change Order.

The Change Order shall include all outstanding Construction Change Directives that the contractor would like to include on an application for payment.

A Change Order must be executed before the Contractor is allowed to add the Work described above on an application for payment.

Owner

University of North Texas (System or Institution Name)

BY (Signature)

[Authorized Signatory Name]
[Authorized Signatory Title]

Date

BY (Signature)

[Authorized Signatory Name]
[Authorized Signatory Title]

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 Specifications Sections apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Division 01 Section 012600 for administrative procedures for handling changes to the Contract.
 - 2. Division 01 Section 013200 for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittal Schedule.
 - 3. Division 00 Section 007000 – University of North Texas System Uniform General Conditions and Supplementary General Conditions 2022, Amended.

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 Application for Payment. The Schedule of Values is a form provided by Owner to Contractor

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules including the following:
 - a. Application for Payment form with Continuation Sheets
 - 2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven calendar days before the date scheduled for submittal of initial Application for Payment.
 - 3. Sub schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules indicating values correlated with each phase of payment.
- B. Format and Content: Use the CIS Divisions 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. The Schedule of Values is formatted using CSI Divisions. (see form instructions)
 - 3. Draft Submittals: Submit in same format as final payment application
 - 4. Arrange the Schedule of Values in tabular form with separate sections to indicate the following for each item listed:
 - a. Related Specification Section or Division
 - b. Change Orders (numbers) that affect value
 - c. Dollar value

- 1) Percentage of the Contract Sum to nearest one-tenth percent adjusted to total 100 percent.

5. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Owner/Architect will review Contractor's Schedule of Values and approve upon receipt of sufficient detail as deemed satisfactory to Owner/Architect.
6. 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. Include evidence of insurance and storage in bonded warehousing for materials stored off-site.
 - b. Major items include but not limited to:
 - Division 01 - General Requirements
 - Division 02 - Existing Conditions
 - Division 03 - Concrete
 - Division 04 - Masonry
 - Division 05 - Metals
 - Division 06 - Wood, Plastics, Composites
 - Division 07 - Thermal and Moisture Protection
 - Division 08 - Openings
 - Division 09 - Finishes
 - Division 10 - Specialties
 - Division 11 - Equipment
 - Division 12 - Furnishings
 - Division 13 - Special Construction
 - Division 14 - Conveying Equipment
 - Division 21 - Fire Suppression
 - Division 22 - Plumbing
 - Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)
 - Division 25 - Integrated Automation
 - Division 26 - Electrical
 - Division 27 - Communications
 - Division 28 - Electronic Safety and Security
 - Division 31 - Earthwork
 - Division 32 - Exterior Improvements
 - Division 33 - Utilities
 - Division 34 - Transportation
 - Division 35 - Waterway and Marine Construction
 - Division 40 - Process Integration
 - Division 41 - Material Processing and Handling Equipment
 - Division 42 - Process Heating, Cooling, and Drying Equipment
 - Division 43 - Process Gas and Liquid Handling, Purification and Storage Equipment
 - Division 44 - Pollution and Waste Control Equipment
 - Division 45 - Industry-Specific Manufacturing Equipment
 - Division 46 - Water and Wastewater Equipment
 - Division 48 - Electrical Power Generation
7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost.
8. In addition to line item costs of Sections in Division 02 thru 39, furnish line item costs for each item of the following general administrative and procedural cost items.
 - a. Bonds

- b. Insurance
- c. Overhead and General Conditions
- d. Contractor's Fee
- 9. Plumbing, HVAC, Electrical and Life Safety work shall be broken down in accordance with the following subcategories as a minimum:
 - a. Fire Protection:
 - b. Plumbing:
 - c. Heating, Ventilating and Air Conditioning (HVAC):
 - d. Electrical:
 - e. Fire Detection and Alarm:

1.5 APPLICATIONS FOR PAYMENT

- A. Electronically deliver in a format approved by Owner after the Design Professional has certified the Payment Application Payment processing will start as soon as we receive
- B. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion and Final Application for Payment involve additional requirements.
- C. Payment Application Times: Progress payment is due once a month.
- D. Payment Application Forms: Use Application for Payment form to be furnished by Owner.
- E. Application Preparation: Complete every entry on form. Application to be Notarized by a Notary and executed 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.
 - 2. Include amounts of Change Order issued before the last day of construction period covered by application.
 - 3. Include supporting documentation including subcontractor and supplier invoices.
- F. Transmittal: Prepare one copy of each Application for Payment by a method ensuring receipt within 24-hours. The copy shall include waivers of lien, schedule updates, contractor's executive summary and similar attachments.
 - 1. Transmit each package with a transmittal form listing attachments and recording appropriate information about application including subcontractor supplemental documentation and required general conditions documents.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from subcontractors, sub-subcontractors and suppliers for construction period covered by the previous application.
 - 1. Submit partial lien waivers on each item for amount requested in previous applications after deduction for retainage of each item.
 - 2. When an application shows completion of an item submit final or full lien waivers.
 - 3. Owner reserves the right to designate which entities involved in the Work must submit lien waivers.
 - 4. Submit final Application for Payment with, or proceeded by, final lien waivers from every entity involved with performance of the Work covered by the application that is lawfully entitled to a lien.
 - 5. Waiver Forms: Submit waivers of lien on forms executed in a manner acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment.
 - 1. Include the following:
 - a. List of subcontractors
 - b. Schedule of Values
 - c. Contractor's Construction Schedule (preliminary if not final)
 - d. Products list
 - e. Submittal Schedule (preliminary if not final)

- f. List of Contractor's staff assignments
 - g. List of Contractor's principal consultants
 - h. Initial progress report
 - i. Report of preconstruction conference
 - j. Certificates of insurance and insurance policies
 - k. Performance and payment bonds
 - l. Data needed to acquire Owner's insurance
- I. Application for Payment at Substantial Completion: After issuing 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 Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: Submit Final Application for Payment within thirty (30) days of Substantial Completion along 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 certificate for products and completed operations where required and proof taxes, fees and similar obligations were paid
 - 3. Updated final statement accounting for final changes to the Contract Sum
 - 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims"
 - 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens"
 - 6. AIA Document G707, "Consent of Surety to Final Payment"
 - 7. Evidence that claims have been settled
- K. Electronic Fund Transfer (EFT): Vendors are required to utilize EFT for the distribution of all future payments. To sign up for EFT, complete the a Payment Works profile (Supplier) at, <https://help.paymentworks.com/contactsupport>. Once established, all future payments will be made by EFT. When an EFT payment is made, an email will be sent to the email address you specify on the Payment Works profile. If you have any questions, please contact the Business Service Center at bsc@untsystem.edu or 940-369-5500.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

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 project coordination procedures
 - 2. Administrative and supervisory personnel
 - 3. Coordination drawings
 - 4. Requests for Information (RFIs)
 - 5. Project Web site
 - 6. Project meetings
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

1.3 DEFINITIONS

- A. RFI: Request from Contractor seeking information from each other during construction.

1.4 COORDINATION

- 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 ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule, continually updated, and in a format acceptable to Owner
 - 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
 - 9. Project closeout activities

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown 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. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Design Professional 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 ceiling plenum to accommodate layout of light fixtures 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, including fire protection requirements.
 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 1¼-inch diameter and larger
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations
 - c. Panel board, switchboard, 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: Design Professional will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Design Professional determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Design Professional will so inform the Contractor (copy the Owner), who shall make changes as directed and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of Division 01 Section 013300, "Submittal Procedures".
- C. Coordination Digital Data Files: Prepare coordination digital data files in accordance with the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as the 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 Portable Data File (PDF) format.

4. Design Professional will furnish Contractor one set of digital data files of the Drawings for use in preparing coordination digital data files. Refer to Division 01 Section 013300, "Submittal Procedures", for digital data file requirements.
 - a. Design Professional makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings.
 - b. Digital Data Software Program: The Drawings are available in [Program].
 - c. Contractor shall execute a data licensing agreement in a form agreeable to the Design Professional.
- 1.6 CHANGE KEY PERSONNEL
- A. Change Key Personnel Names: Changes to key personnel originally stated in the bid response must include a revised list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.
 2. Key personnel must be same as those proposed in the bid response unless changes are authorized in writing from the Associate Vice Chancellor for System Facilities prior to their first day on the project.
- 1.7 REQUESTS FOR INFORMATION (RFIs)
- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI. All RFIs should be sent directly to the Design Professional via email or posted to project collaboration site (if one is being utilized). The Design Professional will redistribute to the appropriate reviewer.
 1. Design Professional will return RFIs submitted to Design Professional by other entities controlled by Contractor with no response.
 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 Design Professional
 6. RFI number, numbered sequentially
 7. RFI subject
 8. RFI Question
 9. Specification Section number and title and related paragraphs, as appropriate
 10. Drawing number and detail references, as appropriate
 11. Field dimensions and conditions, as appropriate
 12. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 13. Contractor's signature
 14. 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 Design Professional. RFIs should be emailed to Design Professional with the following format standards. 1) RFI should include RFI number in subject line of email along with brief description. 2) Body of email should include question or description of RFI and suggestion. Sketches or other necessary documents should be attached to email in PDF format.
 - D. Design Professional's Action: Design Professional will review each RFI, determine action required, and respond. Allow seven (7) business days for Design Professional's response for each RFI. RFIs received by Design Professional after 1:00 p.m. will be considered as received the following working day.
 1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals

- b. Requests for approval of substitutions
 - c. Requests for coordination information already indicated in the Contract Documents
 - d. Requests for adjustments in the Contract Time or the Contract Sum
 - e. Requests for interpretation of Design Professional's actions on submittals
 - f. Incomplete RFIs or inaccurately prepared RFIs
 - 2. Design Professional's action may include a request for additional information, in which case Design Professional's time for response will date from time of receipt of additional information.
 - 3. Design Professional'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 Division 01 Section 012600, "Contract Modification Procedures".
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Design Professional in writing within ten (10) days of receipt of the RFI response.
 - E. On receipt of Design Professional's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Design Professional within seven days if Contractor disagrees with response.
 - F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Log with not less than the following:
 - 1. RFI Log Date
 - 2. Project name
 - 3. Name and address of Contractor
 - 4. Name and address of Design Professional and Construction Manager
 - 5. RFI number including RFIs that were dropped and not submitted
 - 6. RFI description
 - 7. Date the RFI was submitted
 - 8. Request Date
 - 9. Date Design Professional's and Construction Manager's response was received
 - 10. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate
 - 11. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate
- 1.8 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 Design Professional of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees in advance of meeting.
 - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Design Professional, within three (3) days of the meeting.
 - B. Pre-construction Conference: Schedule and conduct a pre-construction conference before starting construction, at a time convenient to Owner and Design Professional, but no later than fifteen (15) days after notice to proceed.
 - 1. Conduct the conference to review responsibilities and personnel assignments.
 - 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, Design Professional, 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.
 - 3. Agenda: Distribute the agenda to all invited attendees in advance of meeting. Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Designation of key personnel and their duties
 - e. Lines of communications
 - f. Procedures for processing field decisions and Change Orders
 - g. Procedures for RFIs
 - h. Procedures for testing and inspecting
 - i. Procedures for processing Applications for Payment
 - j. Distribution of the Contract Documents
 - k. Submittal procedures
 - l. Sustainable design requirements

- m. Preparation of record documents
- n. Use of the premises[and existing building]
- o. Work restrictions
- p. Working hours
- q. Owner's occupancy requirements
- r. Responsibility for temporary facilities and controls
- s. Procedures for moisture and mold control
- t. Procedures for disruptions and shutdowns
- u. Construction waste management and recycling
- v. Parking availability
- w. Office, work, and storage areas
- x. Equipment deliveries and priorities
- y. First aid
- z. Security
- aa. Progress cleaning
- bb. Commissioning requirements/coordination
- 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes within three (3) days of meeting date.
- C. Pre-Installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires 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 Design Professional of scheduled meeting dates.
 - 2. Agenda: Distribute the agenda to all invited attendees in advance of meeting. 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. Review of mockups
 - i. Possible conflicts
 - j. Compatibility problems
 - k. Time schedules
 - l. Weather limitations
 - m. Manufacturer's written recommendations
 - n. Warranty requirements
 - o. Compatibility of materials
 - p. Acceptability of substrates
 - q. Temporary facilities and controls
 - r. Space and access limitations
 - s. Regulations of authorities having jurisdiction
 - t. Testing and inspecting requirements
 - u. Installation procedures
 - v. Coordination with other work
 - w. Required performance results
 - x. Protection of adjacent work
 - y. Protection of construction and personnel
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes within three (3) days of meeting date.
 - 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 Project closeout conference, at a time convenient to Owner and Design Professional, but no later than [number] 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, Design Professional, 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: Distribute the agenda to all invited attendees in advance of meeting. 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. Submittal of written warranties
 - d. Requirements for preparing sustainable design documentation
 - e. Requirements for preparing operations and maintenance data
 - f. Requirements for demonstration and training
 - g. Preparation of Contractor's punch list
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment
 - i. Submittal procedures
 - j. Coordination of separate contracts
 - 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 within three (3) days of meeting date.
- E. Progress Meetings: Conduct progress meetings at agreed upon intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning authority, Construction Manager, and Design Professional, each contractor, 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: Distribute the agenda to all invited attendees in advance of meeting. 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.
Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - Interface requirements
 - Sequence of operations
 - Status of submittals
 - Deliveries
 - Off-site fabrication
 - Access
 - Site utilization
 - Temporary facilities and controls
 - Progress cleaning
 - Quality and work standards
 - Status of correction of deficient items
 - Field observations
 - Status of RFIs
 - Status of proposal requests
 - Pending changes
 - Status of Change Orders
 - Pending claims and disputes
 - Documentation of information for payment requests
 - Recommendations of construction feasibility
 - Safety precautions and programs

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information within three (3) days of meeting date.
 - 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.
- F. Coordination Meetings: Conduct project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
 1. Attendees: In addition to representatives of Owner and Design Professional, 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 meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined 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.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - Interface requirements
 - Sequence of operations
 - Status of submittals
 - Deliveries
 - Off-site fabrication
 - Access
 - Site utilization
 - Temporary facilities and controls
 - Work hours
 - Hazards and risks
 - Progress cleaning
 - Quality and work standards
 - Change Orders
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting, within three (3) days of meeting date.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes within three (3) days of meeting date.
- G. Meetings Requested by Owner: While not necessarily coinciding with dates of other meetings, Owner reserves the right to call and conduct meetings with project participants as the need arises.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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.

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. Contractor's Work Progress Schedule
 - 2. Daily construction reports
 - 3. Material location reports
 - 4. Field condition reports
 - 5. Special reports

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and/or controlling the construction project. Activities included in a construction schedule that 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.
- 1.1 Baseline Schedule: The initial time schedule prepared by Contractor for Owner's information and acceptance that conveys Contractor's and Subcontractors' activities (including coordination and review activities required in the Contract Documents to be performed by Design Professional and Owner), durations, and sequence of work related to the entire Project to the extent required by the Contract Documents. The schedule clearly demonstrates the Longest Path of activities, durations, and necessary predecessor conditions that drive the end date of the schedule. The Baseline Schedule shall not exceed the time limit current under the Contract Documents.
- 1.2 Longest Path: The sequence of directly related activities that comprise the longest continuous chain of activities from the start of the first activity to the finish of the last activity. The activities represent critical path plus float plus historical weather days. Each activity in the Longest Path is critical and directly related in that it prevents its successor from being scheduled earlier than it is.
- B. Event: The starting or ending point of an activity.
- C. Work Progress Schedule: The continually updated time schedule prepared and monitored by the Contractor that coordinates and integrates activities of the Project, including Contractor's services, Design Professional's services, the work of other consultants, suppliers, and Owner's activities with the anticipated construction schedules for other contractors. The WPS accurately indicates all necessary and appropriate revisions including a longest path impact analysis, as required by the conditions of the Work and the Project while maintaining a concise comparison to the Baseline Schedule.
- D. Float: The period of time a task can be delayed without delaying Substantial Completion date.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
 - B. Contractor's Baseline Schedule: Initial Baseline Schedule due with Guaranteed Maximum Price in a Construction Manager-At-Risk and with the Proposal Response in a CSP, of size required to display entire schedule for entire construction period. The Baseline Schedule shall become the comparison to the actual conditions throughout the Contract duration and become part of the Contractor's Work Progress Schedule.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (baseline or updated) and date on label.
 - C. WPS Reports: Concurrent with WPS schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, and remaining duration in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity.
 3. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
 - D. Material Location Reports: Submit at prior to application for payment
 - E. Field Condition Reports: Submit at time of discovery of differing conditions
 - F. Special Reports: Submit at time of unusual event
- 1.5 QUALITY ASSURANCE
- A. Scheduling Consultant Qualifications: An experienced specialist in WPS scheduling and reporting, with capability of producing WPS reports and diagrams within twenty-four (24) hours of Design Professional's request.
- 1.6 COORDINATION
- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
 - B. Coordinate Contractor's construction schedule with the schedule of values, 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.

PART 2 - PRODUCTS

- 2.1 CONTRACTOR'S WORK PROGRESS SCHEDULE, GENERAL
- A. Time Frame: Extend schedule from date established for commencement of the Work 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.
 - B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 1. Procurement Activities: Include procurement process activities for long lead items (as identified by Contractor) and major items, requiring a cycle of more than sixty (60) days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 2. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section 013300, "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 3. Startup and Testing Time: Include not less than fifteen (15) days for startup and testing.
 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Design Professional's administrative procedures necessary for certification of Substantial Completion.
 5. Punch List and Final Completion: Include not more than thirty (30) days for punch list and final completion.
 - C. 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. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section 011000, "Summary". Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section 011000, "Summary". Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing conditions
 - b. Limitations of continued occupancies
 - c. Uninterruptible services
 - d. Partial occupancy before Substantial Completion
 - e. Use of premises restrictions

- f. Lead time for future construction
 - g. Seasonal variations
 - h. Environmental control
 - 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards
 - b. Submittals
 - c. Purchases
 - d. Mockups
 - e. Fabrication
 - f. Sample testing
 - g. Deliveries
 - h. Installation
 - i. Tests and inspections
 - j. Adjusting
 - k. Curing
 - l. Startup and placement into final use and operation
 - 8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion
 - b. Permanent space enclosure
 - c. Completion of mechanical installation
 - d. Completion of electrical installation
 - e. Substantial Completion
 - D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
 - E. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
 - 1. Refer to Division 01 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 RFIs
 - 3. Rejected or unreturned submittals
 - 4. Notations on returned submittals
 - G. Recovery Schedule: When periodic update indicates the Work is fourteen (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, and equipment required for compliance, and date by which recovery will be accomplished.
 - H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules. Confirm acceptability of software with Owner. Contractor is responsible for all costs associated with licensing and training of the software.
 - I. Schedule shall be updated with the weekly OAC meeting and must include current details for all activities.
- 2.2 CONTRACTOR'S WORK PROGRESS SCHEDULE (WPS SCHEDULE)
- A. General: Contractor shall submit for review and approval a Baseline Schedule that will indicate starting and completing dates of various aspects required to complete the work using the Longest Path. The Baseline Schedule shall become the comparison to the actual conditions throughout the contract and become a part of the Work Progress Schedule.
 - B. Contractor's Work Progress Schedule (WPS) shall coordinate and integrate the services and activities of Contractor, Design Professional and Owner, other consultants/suppliers, subcontractors and requirements of governmental entities. The WPS is due within twenty-one (21) days after the effective date of Notice to Proceed.
 - C. Contractor shall be responsible to:
 - 1. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel and Owner's Representative, in proper methods of providing data and using WPS information.
 - 2. Establish procedures for monitoring and updating WPS and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to correlate with Contract Time.
 - D. WPS Preparation: Prepare a list of all activities required to complete the Work.
 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals
 - b. Mobilization and demobilization
 - c. Purchase of materials
 - d. Delivery
 - e. Fabrication
 - f. Utility interruptions
 - g. Installation
 - h. Work by Owner that may affect or be affected by Contractor's activities
 - i. Testing
 - j. Punch list and final completion
 - k. Activities occurring following final completion
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer drawn, time scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the WPS within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Sub-networks on separate sheets are permissible for activities clearly off the critical path.
 - E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time impact analysis to demonstrate the effect of the proposed change on the overall project schedule.
 - F. Initial Issue of Schedule: Prepare initial schedule from a sorted activity list indicating straight "early start ". Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity
 2. Description of activity
 3. Principal events of activity
 4. Immediate preceding and succeeding activities
 5. Activity duration in workdays
 - G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed
 2. Changes in activity durations in workdays
 3. Changes in the critical path
 4. Changes in total float time
 5. Changes in the Contract Time
 6. Show relationship between activities on initial and updated schedule.
- 2.3 REPORTS
- A. Daily Construction Reports: Prepare a daily construction report record 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. Accidents
 8. Meetings and significant decisions
 9. Unusual events (refer to special reports)
 10. Stoppages, delays, shortages, and losses
 11. Meter readings and similar recordings
 12. Emergency procedures
 13. Orders and requests of authorities having jurisdiction
 14. Change Orders received and implemented
 15. Construction Change Directives received and implemented
 16. Services connected and disconnected
 17. Equipment or system tests and startups

- 18. Partial completions and occupancies
 - 19. Substantial Completions authorized
 - B. Material Location Reports: Monthly prepare and submit a comprehensive list of materials delivered to and stored at Project site. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
 - C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents prepare and submit, to the Design Professional, 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.
 - D. Executive Summary Reports: Provided monthly with Payment Applications. Provides highlight details, schedule summary, and other information pertinent to Owner, including, but not limited to the following:
 - 1. Table of contents, simple project schedule clearly indicating benchmark dates, a narrative stating the current status of construction, a list of construction concerns, a look at what is coming up, potential change order log, and progress photo's.
- 2.4 SPECIAL REPORTS
- A. General: Submit special reports directly to Owner within one (1) day of an occurrence. Distribute copies of report to parties affected by the occurrence.
 - B. Reporting Unusual Events: 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, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

- 3.1 CONTRACTOR'S WORK PROGRESS SCHEDULE
- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using WPS scheduling.
 - 1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in WPS scheduling and reporting techniques. Submit qualifications.
 - 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
 - B. Contractor's WPS Updating: Update and submit the WPS with the OAC meeting minutes to reflect actual construction progress and activities.
 - 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.
 - C. Distribution: Distribute copies of approved schedule to Design Professional, Owner, commissioning agent, 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.

END OF SECTION

SECTION 013233

PHOTOGRAPHIC 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.
- 1.2 SUMMARY
 - A. Section includes administrative and procedural requirements for the following:
 - 1. Pre-construction photographs
 - 2. Periodic construction photographs
 - 3. Final completion construction photographs
 - 4. Owner may elect to retain an independent firm to photographically document the progress of the work. Work of this firm shall not diminish or replace responsibilities of the Contractor for documentation required by this section. Contractor to cooperate fully with independent photographer.
- 1.3 UNIT PRICES
 - A. Basis for Bids: Base number of construction photographs on average of twenty (20) photographs per week over the duration of Project.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
 - 2. Format: Minimum 1600 by 1200 pixels, 400 dpi minimum, in unaltered original files, with same aspect ratio as the sensor, un-cropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project
 - b. Name of Design Professional
 - c. Name of Contractor
 - d. Date photograph was taken
 - e. Description of location, direction (by compass point), and elevation or story of construction
- 1.5 COORDINATION
 - A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities.
- 1.6 USAGE RIGHTS
 - A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

- 2.1 PHOTOGRAPHIC MEDIA
 - A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 1600 by 1200 pixels and 400 dpi.

PART 3 - EXECUTION

- 3.1 CONSTRUCTION PHOTOGRAPHS
 - A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
 - B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image editing software.
 - 1. Date and Time: Include date and time in file name for each image.

2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- C. Pre-construction Photographs: Before commencement of excavation, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 1. Flag construction limits before taking construction photographs
 2. Take twenty (20) photographs to show existing conditions adjacent to property before starting the Work
 3. Take twenty (20) photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction
 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take twenty (20) photographs monthly (unless otherwise directed), coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Time-lapse Sequence Construction Photographs: Take photographs as indicated, to show status of construction and progress since last photographs were taken.
 1. Frequency: Take photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment.
 2. Vantage Points: Following suggestions by Architect and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
 - a. Commencement of the Work, through completion of subgrade construction
 - b. Above-grade structural framing
 - c. Exterior building enclosure
 - d. Interior Work, through date of Substantial Completion

END OF SECTION

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.

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Design Professional'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 Design Professional'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.
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule 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 modifications to submittals noted by the Design Professional 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: Submit concurrently with start-up construction schedule. Include submittals required during the first sixty (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.
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 Design Professional's final release or approval
 - g. Scheduled dates for purchasing
 - h. Scheduled dates for installation
 - i. Activity or event number

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Design Professional's Digital Data Files: Design Professional will provide electronic copies of CAD Drawings for Contractor's use in preparing coordination submittals.
 - 1. Design Professional will furnish Contractor one (1) set of drawing files for use in preparing Shop Drawings and Project record drawings.

2. Design Professional makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 3. Digital Drawing Software Program: The Contract Drawings are available in [Type] software.
 4. Contractor shall execute a data licensing agreement in the form of Agreement included in Project Manual.
 5. CAD files will be furnished for each appropriate discipline.
- 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 approved by Design Professional.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 5. Design Professional 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 Design Professional'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. Submittals received after 1:00 pm will be considered to have been received the following day.
1. Allow ten (10) business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Design Professional will advise Contractor when a submittal being processed must be delayed for coordination. Allow fifteen (15) business days for review time for large or complex submittals will require additional review time. The following are examples but not limited to such submittals, Millwork, Curtain Wall, Structural Steel, Doors, Frames, Hardware (total opening).
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow ten (10) business days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Design Professional's consultants, Owner, or other parties is indicated, allow fifteen (15) business days for initial review of each submittal.
- D. Identification and Information: Place a permanent label or title block on each copy submittal item for identification.
1. On large format Shop Drawings, Contractor shall stamp each individual page as well as the reviewer's stamp.
 2. Indicate name of firm or entity that prepared each submittal on label or title block.
 3. Provide a space approximately 6-inches by 8-inches on label or beside title block to record Contractor's review and approval markings and action taken by Design Professional.
 4. Include the following information for processing and recording action taken:
 - a. Project name
 - b. Date
 - c. Name of Design Professional
 - d. Name of Contractor
 - e. Name of subcontractor
 - f. Name of supplier
 - g. Name of manufacturer
 - h. Submittal number or other unique identifier, including revision identifier
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - i. Number and title of appropriate Specification Section
 - j. Drawing number and detail references, as appropriate
 - k. Location(s) where product is to be installed, as appropriate
 - l. Other necessary identification
- E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.

- a. For typical projects that do not require separate submittals for different buildings or sub the submittal file name shall use Specification Section number followed by a dash and then a sequential number. Resubmittals shall include an numerical suffix after another dash. Include brief description of submittal after sequential number or resubmittal suffix. (e.g., 061000-001-0 Rough Carpentry).
 - b. For complex projects that require project identifier for separate buildings within a project or require individual submittals to be submitted by multiple subcontractors, the submittal file name shall follow the following: Specification Section number followed by a decimal point and then a sequential number. Resubmittals shall include an alphabetic suffix after another decimal point. Project Identifier should follow in parentheses (e.g., 061000-001-0 (LNHS) Rough Carpentry).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Design Professional.
4. Include the following information on an inserted cover sheet:
 - a. Project name
 - b. Date
 - c. Name and address of Design Professional
 - d. Name of Contractor
 - e. Name of firm or entity that prepared submittal
 - f. Name of subcontractor
 - g. Name of supplier
 - h. Name of manufacturer
 - i. Number and title of appropriate Specification Section
 - j. Drawing number and detail references, as appropriate
 - k. Location(s) where product is to be installed, as appropriate
 - l. Related physical samples submitted directly
 - m. Other necessary identification
5. Include the following information as keywords in the electronic file metadata:
 - a. Project name
 - b. Number and title of appropriate Specification Section
 - c. Manufacturer name
 - d. Product name
- F. Options: Identify options requiring selection by the Design Professional.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Design Professional observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 1. Submit one (1) copy of submittal to concurrent reviewer in addition to specified number of copies to Design Professional.
- I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Design Professional will return submittals, without review, received from sources other than Contractor.
 1. Transmittal Form: Use standard contractor form as approved by Design Professional Owner.
 2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Design Professional on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- J. 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. Include all submitted information from previous submittal in resubmittal, to form a comprehensive document for Design Professional's review.
 4. Resubmit submittals until they are marked with 'Reviewed', 'Furnish as Corrected' notation from Design Professional's action stamp, or with approval notation from alternate reviewer
- K. 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.
- L. Use for Construction: Use only final submittals that are marked with 'Reviewed', 'Furnish as Corrected' notation from Design Professional's action stamp, or with approval notation from alternate reviewer.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email or upload electronic submittals as PDF electronic files directly to Design Professional's Info Exchange Folder specifically established for Project.
 - a. Design Professional will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Action Submittals: For large format drawings and submittals (larger than 11x17), submit PDF file plus two (2) hard copies. For smaller format drawings and submittals (11x17 or less), provide only PDF file. Design Professional will return only the marked-up PDF.
 3. Informational Submittals: Submit two paper copies of each submittal, unless otherwise indicated. Design Professional will not return copies.
 4. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section 017700, "Closeout Procedures".
 5. Certificates and Certifications Submittals: Provide 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.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
 6. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section 014000, "Quality Requirements".
- B. 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 not suitable 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 showing 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 or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file
- C. Shop Drawings: Prepare Project specific information, drawn accurately to scale.
1. Submittals containing reproduction of Contract Drawings are not considered Shop Drawings and will be returned without action. Any delay due to such rejection will not be grounds for an extension of Contract Time.
 2. 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
 3. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 4. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8 ½ -inches by 11-inches but no larger than 30-inches by 42-inches.

5. Submit Shop Drawings in the following format:
 - a. For large format drawings and submittals (larger than 11 x 17), submit PDF file plus two (2) hard copies. For smaller format drawings and submittals (11x17 or less), provide only PDF file. Design Professional will return only the marked-up PDF.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample
 - b. Product name and name of manufacturer
 - c. Sample source
 - d. Number and title of applicable Specification Section
 3. 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.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit three (3) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Design Professional will return submittal with options selected.
 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 sets of Samples. Design Professional will retain one sample set; 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.
- E. 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.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space
 4. Location within room or space
 5. Submit product schedule in the following format:
 - a. PDF electronic file
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section 013200, "Construction Progress Documentation".
- G. Application for Payment: Comply with requirements specified in Division 01 Section 012900, "Payment Procedures".
- H. Schedule of Values: Comply with requirements specified in Division 01 Section 012900, "Payment Procedures".
- I. 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. Use CSI Form 1.5A. Include the following information in tabular form:
 1. Name, address, and telephone number 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.

4. Submit subcontract list in the following format:
 - a. PDF electronic file
 - J. Coordination Drawings: Comply with requirements specified in Division 01 Section 013100, "Project Management and Coordination".
 - K. 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 Design Professionals and owners, and other information specified.
 - L. 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 American Welding Society (AWS) forms. Include names of firms and personnel certified.
 - M. 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.
 - N. 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.
 - O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
 - P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
 - Q. 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.
 - R. Product Test Reports: Submit written reports indicating 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.
 - S. 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:
 1. Name of evaluation organization
 2. Date of evaluation
 3. Time period when report is in effect
 4. Product and manufacturers' names
 5. Description of product
 6. Test procedures and results
 7. Limitations of use
 - T. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section 014000, "Quality Requirements".
 - U. Pre-construction 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.
 - V. 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.
 - W. Field Test Reports: Submit reports indicating and interpreting results of field tests either performed during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 - X. Maintenance Data: Comply with requirements specified in Division 01 Section 017823, "Operation and Maintenance Data".
 - Y. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions, other performance and design criteria, and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- 2.2 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 Design Professional.

- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three (3) 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action 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 Design Professional.
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 01 Section 017700, "Closeout Procedures".
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, 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.

3.2 DESIGN PROFESSIONAL'S ACTION

- A. General: Design Professional will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Design Professional will review each submittal, make marks to indicate corrections or modifications required, and return it. Design Professional will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
 - 1. Reviewed
 - 2. Revise and Resubmit
 - 3. Rejected
 - 4. Furnish As Corrected
 - 5. No Action Taken
- C. Informational Submittals: Design Professional will review each submittal and will not return it, or will return it if it does not comply with requirements. Design Professional will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Design Professional.
- E. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION



April 1, 2025
Issue for Construction

SUBCONTRACTORS AND MAJOR MATERIAL SUPPLIERS LIST

Project: _____

To (A/E): _____

From (Contractor): _____
Date: _____
A/E Project Number: _____
Contract For: _____

List Subcontractors and Major Material Suppliers proposed for use on this Project as required by the Construction Documents. Attach supplemental sheets if necessary.

Section Number	Section Title	Firm	Address	Phone Number (Fax Number)	Contact
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☐ Attachments

Signed by: _____ Date: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

SECTION 013516

ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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. Products and installation for patching and extending Work within construction areas of existing facilities.
2. Providing transition and adjustments
3. Repair of damaged surfaces and finishes

B. Related Sections include the following:

1. Division 01 Section 015000 "Temporary Facilities and Controls" for construction of temporary fire-rated partitions to separate existing occupied areas from construction areas.

1.3 OCCUPANCY, ACCESS, AND PROTECTION

- A. Entire existing facility or any portion thereof will be occupied during progress of construction for conduct of normal operations. Phase Work in accordance with Section 011000, "Summary".
- B. Cooperate with Owner in scheduling operations to minimize conflict and to permit continuous usage. Perform work not to interfere with operations of occupied areas.
- C. Existing facilities will remain in full operation during execution of this Work. Exercise every precaution to ensure safety and protection for existing facilities, occupants, merchandise, pedestrians, and vehicles. The following must meet required codes and accessibility requirements.
 1. Maintain safe access and egress at all times for occupants, pedestrians, and vehicles.
 2. Provide protection to prevent damage to facilities, merchandise, and vehicles from dust, water, weather, and other similar harmful elements. Refer to Section 015000, "Temporary Facilities and Controls" for additional requirements.
 3. Maintain exiting from facilities to provide safe passage complying with applicable codes.

1.4 SCHEDULING OF WORK

- A. Make arrangements with Owner and schedule Work to avoid interference with normal operations of occupied areas. Submit schedule and summary of applicable Work within occupied areas and obtain Owner approval not less than two (2) days prior to commencement of such Work.
 1. Requests for use of certain existing loading docks, passage ways, and other similar spaces within areas outside limits of construction operations will be limited to day-by-day basis and must be approved in advance by Owner.
- B. Coordinate access and scheduling of Work within tenant areas with Owner.

1.5 TORCH-CUTTING AND WELDING PROCEDURES

- A. Notify Owner in advance of torch-cutting and welding operations performed within occupied areas; obtain approval prior to proceeding with such operations.
 1. Neither open-flame torch-cutting, welding nor arc-welding are allowed without having secured appropriate permit from Fire Marshal or authority having jurisdiction.
 2. Keep portable fire extinguisher of appropriate class within reach during welding or torch-cutting operations.
 3. Screen arc-welding from vision of passersby.
- B. Maintain a "Fire Watch" for minimum of sixty (60) minutes after completion of each torch-cutting and welding operation.

1.6 UTILITY SERVICE OUTAGES

- A. Keep utility and service outages to minimum and perform only after written approval of Owner is received.
 1. Requests for outages will not be considered unless they include an identification of areas which will

- be affected by proposed outage.
 - 2. Schedule outages for times other than normal business hours.
 - 3. Make requests for outages minimum of five (5) calendar days in advance of proposed outage.
 - B. Contractor: Responsible for investigating utility and service lines to determine effect of outage upon building operations outside of limit of operations. Obtain approval in advance from Owner to execute investigations.
- 1.7 KEYS
- A. When necessary to perform Work, Owner will issue keys to existing mechanical/electrical equipment spaces.
 - B. Return keys at end of warranty period.

PART 2 - PRODUCTS

- 2.1 MATERIALS
- A. Type and Quality of Existing Products: Use products or types of construction that exist in structure, as needed to patch, extend, or match existing Work.
 - 1. Generally, Contract Documents do not define products or standards of workmanship present in existing construction.
 - 2. Determine by inspecting and testing products where necessary, referring to existing work as quality standard.
 - B. New Materials: Comply with Specifications for each product involved.
 - 1. Match existing products and work for patching existing work.
 - C. Materials for Temporary Fire-Rated Partitions: Comply with provisions of Division 01 Section 015000 "Temporary Facilities and Controls".
 - D. Salvaged Materials: Salvage sufficient quantities of cut or removed material to replace damaged Work of existing construction, when material is not readily obtainable on current market.
 - 1. Store salvaged items in dry, secure place on site.

PART 3 - EXECUTION

- 3.1 EXAMINATION
- A. Comply with provisions of Division 01 Section 017300, "Execution".
 - 1. Responsible for verifying existing conditions to determine that all areas meet constructability and are ready for alteration and remodeling.
 - B. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
 - 1. Prior to commencing work, carefully compare and check Contract Documents for discrepancies in locations or elevations of work to be executed.
 - 2. Refer discrepancies among Drawings and existing conditions to Design Professional for adjustment before work affected is performed.
- 3.2 PREPARATION
- A. Construct temporary fire-rated partitions to separate existing occupied areas from construction and alteration areas. Comply with provisions of Division 01 Section 015000, "Temporary Facilities and Controls".
 - B. Cut, move, or remove items as necessary for access to alteration and renovation Work.
 - 1. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, deteriorated masonry and concrete, and other deteriorated materials. Replace materials as specified for finished Work.
 - 2. Remove debris and abandoned items from area and from concealed spaces.
 - C. Cutting and Removal: Perform cutting and removal work to remove minimum necessary, and in manner to avoid damage to adjacent work. Cut finish surfaces such as masonry, tile, plaster, or metals by methods to terminate surfaces in straight line at natural point of division.
 - D. Prepare surfaces and remove surface finishes as necessary to provide for proper installation of new materials and finishes.
 - E. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity. Insulate ductwork and piping to prevent condensation in exposed areas.
 - F. Provide temporary barriers and closures to control operations to prevent spread of dust to occupied portions of building; refer to Division 01 Section 015000, "Temporary Facilities and Controls".

3.3 INSTALLATION

- A. Coordinate Work of alterations and renovations to expedite completion and to accommodate Owner occupancy.
- B. Remove, cut, and patch Work in manner to minimize damage and to provide means of restoring products and finishes to specified condition.
 - 1. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.
- C. Install products as specified in individual Specification sections.
- D. Where new Work abuts or aligns with existing, perform smooth and even transition to match existing adjacent surface in texture and appearance.
 - 1. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and request instructions from Design Professional as to method of making transition.

3.4 ADJUSTMENTS

- A. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth plane without breaks, steps, or soffits.
- B. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.
- C. Fit Work at penetrations of surfaces as specified in Division 01 Section 017300, "Execution".
- D. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections. Repair substrate prior to application of finishes.

3.5 FINISHES

- A. Finish new surfaces as specified in individual Specification sections.
- B. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

3.6 CLEANING

- A. Comply with Division 01 Section 017700, "Closeout Procedures". Thoroughly clean areas and spaces affected by Work. Completely remove paint, mortar, oils, putty and items of similar nature.
- B. Clean Owner occupied areas daily. Clean spillage, overspray, and heavy collection of dust in Owner occupied areas immediately.

END OF SECTION

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 inspecting 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 control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and control services required by Design Professional, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
 - 1. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. 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.
- B. 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. Services do not include contract enforcement activities performed by Design Professional.
- C. Mockups: Full size physical assemblies that are constructed onsite. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, 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. Laboratory Mockups: Full-size, physical assemblies constructed at testing facility to verify performance characteristics.
 - 2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on the project site, consisting of multiple products, assemblies and subassemblies.
 - 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
- D. Pre-construction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- G. Field Quality Control Testing: Tests and inspections that are performed onsite for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. 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, 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 or trades.

- J. Experienced: When used with an entity or individual, "experienced" 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.
- 1.4 CONFLICTING REQUIREMENTS
- A. Referenced Standards: If compliance with two or more standards is specified and the standards 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 Design Professional and Owner for a decision 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 Design Professional for a decision before proceeding.
- 1.5 ACTION SUBMITTALS
- A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
1. Indicate manufacturer and model number of individual components.
 2. Provide axonometric drawings for conditions difficult to illustrate in two (2) dimensions.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Contractor's Quality Control Plan: For quality assurance and quality control activities and responsibilities.
- B. Contractor's Quality Control Manager Qualifications: For supervisory personnel.
- C. 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.
- D. 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 timespan for tests and inspections
 8. Requirements for obtaining samples
 9. Unique characteristics of each quality control service
- 1.7 CONTRACTOR'S QUALITY CONTROL PLAN
- A. Quality Control Plan, General: Submit quality control plan within ten (10) days of Notice to Proceed, and not less than five (5) days prior to pre-construction conference. Submit in format acceptable to Design Professional. 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 full-time 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: Include in quality control plan 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's elected tests and inspections.
 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections".
 3. Owner performed tests and inspections indicated in the Contract Documents including tests and inspections indicated to be performed by the Commissioning Authority, if applicable.
- 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 Design Professional 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.

1.8 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, and telephone number 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 inspecting.
 - 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, and telephone number 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, and telephone number 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.
- D. Permits, Licenses, and Certificates: For Owner's records, 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.

1.9 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.
- 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, 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 that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting 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.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. 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.
- I. 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.
- J. Pre-construction Testing: Where testing agency is indicated to perform pre-construction 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, assemblies, 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 Design Professional, 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.
- K. 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 in location and of size indicated or, if not indicated, as directed by Design Professional.
 2. Notify Design Professional five (5) business days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at the Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Design Professional's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven (7) days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed, unless otherwise indicated.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup in accordance with approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual specification sections, along with supporting materials.
- M. [Room Mockups: Construct room mockups incorporating required materials and assemblies, finished in accordance with requirements. Provide required lighting and additional lighting where required to enable Design Professional to evaluate quality of the Work. Provide room mockups of the following rooms:
_____].
- N. [Laboratory Mockups: Comply with requirements of pre-construction testing and those specified in individual Specification Sections in Divisions 02 through 49.]

1.10 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 inspecting they are engaged to perform.
 - 2. 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, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
 - 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. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these 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 inspecting 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 inspecting 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. 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 Division 01 Section 013000, "Submittal Procedures".
- D. 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.
- E. Re-testing/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.
- F. Testing Agency Responsibilities: Cooperate with Design Professional and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Design Professional and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location 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. Does not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies 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 inspecting 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 inspecting equipment at Project site
- H. Coordination: Coordinate sequence of activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to

accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency 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 Owner, Design Professional 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 Design Professional with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, this 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. 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 Design Professional
 4. Identification of testing agency or special inspector conducting test or inspection
- B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Design Professional's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section 017300, "Execution".
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION

UNT SYSTEM REGULATORY REQUIREMENTS

SECTION 014100

PART 1 GENERAL

- 1.1 SUMMARY: For all building construction projects on state-owned and state-controlled property (including privately owned buildings built on state-owned and state-controlled property), state agency leased buildings and leased spaces, the adopted editions of the *National Fire Protection Association (NFPA) 101 Life-Safety Code* and *NFPA 1 Fire Code* shall be used as the primary building design codes. Where NFPA 101 or NFPA 1 do not address the specific design/construction under consideration, the adopted edition of the International Code Conference (ICC) code applicable to the design/construction discipline shall be used.

A. Design and construction codes applicable to UNT System projects, however, the following list is not to be considered all-inclusive:

1. National Fire Protection Association (NFPA) Codes/Standards to use are, but not limited to:
 - a. 2021 edition NFPA 1 Fire Code
 - b. 2019 edition NFPA 13 Standard for the installation of [Fire] Sprinkler Systems
 - c. 2019 edition NFPA 14 Standards for the Installation of Standpipe and Hose Systems
 - d. 2019 edition NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
 - e. 2019 edition NFPA 24 Standard for the Installation of Private Fire Service Mains and Their Appurtenances
 - f. 2023 edition NFPA 70 National Electric Code
 - g. 2019 edition NFPA 72 National Fire Alarm Signaling Code
 - h. 2021 edition NFPA 101 Life Safety Code
2. International Building Code Conference (ICC)
 - a. 2021 edition International Building Code (IBC)¹,
 - b. 2021 edition International Mechanical Code (IMC),
 - c. 2021 edition International Plumbing Code (IPC),
 - d. 2021 edition International Fuel Gas Code (IFGC)
 - e. 2021 edition International Fire Code (IFC),
3. Local Jurisdiction Codes: *"The State Fire Marshal's Office has directed all state universities and agencies who depend on local fire departments for emergency response and fire suppression to design their construction project with the local fire department in mind. Building and site design shall ensure water supply for fire suppression; fire department access to buildings; locations and compatibility of fire hydrant and fire department connections; fire sprinkler systems; standpipe and hose systems; alarm systems; and other emergency equipment for buildings are constructed for use by the respective local fire department"*².

Local fire code requirements of the respective city where the construction is located (i.e. Denton, Frisco, Dallas and Ft. Worth) pertaining only to the following shall be incorporated into the project's design and construction:

- i) water supply for fire suppression;
- ii) fire hydrant number and locations;
- iii) fire department access to the building;
- iv) KNOX® key access boxes – contact UNT System Fire Marshal for specifics (see below);
- v) fire department connections (FDC & its location);
- vi) fire sprinkler and standpipe systems;
- vii) fire hose connections;
- viii) fire detection & alarm systems;

¹ Adopted as State of Texas Building Code

² Memorandum to State Universities "Co-operation with Local Jurisdictions and Fire Departments", G. Mike Davis, State Fire Marshal, July 1, 2001; Chris Connealy, State Fire Marshal, February 4, 2016.

- ix) elevator emergency operations requirements, and cab sized for stretcher requirements;
- x) bi-directional antenna communication coverage;
- xi) other emergency equipment requirements;
- xii) A *Fire Fighter Air Replenishment System (FARS)* shall be designed and installed in any new building in compliance with the respective city's fire code amendments and per the requirements of the *2021 International Fire Code (IFC), Appendix L, where adopted by the respective city.*

The following links to municipal fire codes are provided only for informational references. Always check for the latest municipal revisions. (municipal list revised 11/2024)

- [Dallas Fire Code Amendments](#)
- [Ft. Worth Fire Code Amendments](#)
- [Denton Fire Code Amendments](#)
- [Frisco Fire Code Amendments](#)

KNOX® key boxes are required to be installed on all state-owned buildings, on buildings located on state-owned or state-controlled property (includes privately owned buildings built on state-owned or state-controlled property) and on buildings leased by or containing leased space by a state agency. For ordering details, contact the UNT System Fire Marshal's Office – pat.dunlap@untsystem.edu or Jackie.miller@untsystem.edu

4.. *Design & Construction Guidelines* –

- a. *The University of North Texas* (access the UNT Facilities Resources webpage at

https://facilities.unt.edu/images/unt_design_and_construction_standards_2024_09.pdf. For design guidelines specific to UNT Discovery Park – access the UNT facilities Resources webpage at [UNT Discovery Park Design Guidelines](#)

- a. Questions regarding the *Design & Construction Guidelines – The University of North Texas* are to be emailed to: Peter.Palacios@unt.edu
3. Elevator and Escalator Construction
- a. *Elevators, Escalators and Related Equipment, Administrative Rules of the Texas Department of Licensing and Regulation, 16 Texas Administrative Code, Chapter 74, §74.100 (Effective February 15, 2016).*
- b. 2021 edition International Building Code (IBC), Chapter 30.
4. Accessibility Standards
- a. *2012 Texas Accessibility Standards (2012 TAS). (Elimination of Architectural Barriers Texas Government Code, Chapter 469. Administered by the Texas Department of Licensing and Regulation. Effective March 15, 2012).*
5. Energy Conservation Design Standards for New Construction and Major Renovation³ Projects:
- Commercial Construction and Major Commercial Renovation⁴: *Commercial Provisions of the 2018 International Energy Conservation Code (IECC)*⁵
- a. ;

³ Major Renovation Projects: *For the purposes of this subchapter, a major renovation project is a building renovation or improvement where the implementation cost associated with energy or water efficiency improvements is \$2 million or more, based on the initial engineering cost estimate. [34 Tex. Admin. Code §19.33.](#)*

Source Note: *The provisions of this §19.33 adopted to be effective August 13, 2002, 27 TexReg 7174; amended to be effective September 28, 2011, 36 TexReg 6303; amended to be effective April 7, 2016, 41 TexReg 2495.*

⁴Major Renovation Projects: *For the purposes of this subchapter, a major renovation project is a building renovation or improvement where the implementation cost associated with energy or water efficiency improvements is \$2 million or more, based on the initial engineering cost estimate. [34 Tex. Admin. Code §19.33.](#)*

⁵ [34 Tex. Admin Code §19.32](#)

- Low-Rise Residential Building⁶: *Residential Provisions of the 2018 International Energy Conservation Code (IECC)*⁷
- b. ASHRAE 90.1 – 2016 edition.
- 6. Water Conservation Standards
 - “Water Conservation Design Standards for State Buildings and Institutions of Higher Education Facilities” prepared by SECO, dated April 2020, as the water conservation design standards for any new construction or major renovation project. Download available at: <https://comptroller.texas.gov/programs/seco/code/>
 - a.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

⁶ Low-Rise Residential Building: Buildings not more than three stories in height above grade that includes sleeping accommodations and a separate means of egress, and where the occupants are primarily permanent in nature (30 or more days in occupancy).

⁷ 34 Tex. Admin Code §19.32

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 Design Professional's action on Contractor's submittals, applications, and requests, "approved" is limited to Design Professional's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Design Professional. 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": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- 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 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.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

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 indicated in Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Following are acronyms used by Owner in the Contract Documents:
 - 1. A/E: Architect/Engineer
 - 2. AHJ: Authority Having Jurisdiction
 - 3. BOR: Board of Regents
 - 4. CCD: Construction Change Directive
 - 5. CCL: Construction Cost Limitation
 - 6. CMAR: Construction Manager at Risk
 - 7. CSP: Competitive Sealed Proposal
 - 8. DD: Design Development
 - 9. FPE: Fire Protection Engineer
 - 10. GCs: General Conditions
 - 11. GMP: Guaranteed Maximum Price
 - 12. GSF: Gross Square Feet
 - 13. HSP: HUB Subcontractor Plan

14.	HUB:	Historically Underutilized Business
15.	LA:	Landscape Architect
16.	LEED:	Leadership in Energy and Environmental Design
17.	LDs:	Liquidated Damages
18.	NASF:	Net Assignable Square Feet
19.	NTP:	Notice to Proceed
20.	OAC:	Owner/Architect/Contractor
21.	OCM:	Owner's Construction Manager
22.	ODR:	Owner's Designated Representative
23.	PAR:	Progress Assessment Report
24.	PE:	Professional Engineer
25.	PM:	Project Manager
26.	RID:	Registered Interior Designer
27.	R&R:	Repair and Rehabilitation
28.	SD:	Schematic Design
29.	SDs:	Schematic Design Drawings
30.	UGC/SGC:	Uniform General Conditions/Supplemental General Conditions

END OF SECTION

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.

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 to use temporary services and facilities without cost, including, but not limited to, Owner's own forces, Design Professional, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Owner will pay sewer service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Owner will pay water service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Owner will pay electric power service use charges for electricity used by all entities for construction operations.
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- C. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage, including delivery, handling, and storage provisions for materials subject to water absorption or water damage, discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged Work.
 - 1. 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.
- D. Dust-Control and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust-control and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. Locations of dust-control partitions at each phase of the work
 - 2. HVAC system isolation schematic drawing
 - 3. Location of proposed air filtration system discharge
 - 4. Other dust-control measures
 - 5. Waste management plan
 - 6. Comply with other requirements on a per Campus basis

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.

- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

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. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized steel, chain-link fabric fencing; minimum 6-feet high with galvanized steel pipe posts; minimum 2 $\frac{3}{8}$ -inch OD line posts and 2 $\frac{7}{8}$ -inch OD corner and pull posts, with 1 $\frac{5}{8}$ -inch OD top rails.
- B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized steel, chain-link fabric fencing; minimum 6-feet high with galvanized steel pipe posts; minimum 2 $\frac{3}{8}$ -inch OD line posts and 2 $\frac{7}{8}$ -inch OD corner and pull posts, with 1 $\frac{5}{8}$ -inch OD top and bottom rails. Provide galvanized steel bases for supporting posts.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mils minimum thickness, with flame-spread rating of 15 or less per ASTM E 84.
- D. Dust Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches.
- E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

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, Design Professional, Construction Manager, 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:
 - 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 not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Lighting fixtures capable of maintaining average illumination of 20 FC at desk height.
- C. 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. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 3. 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 Division 01 Section 017700 "Closeout Procedures".
- C. Air Filtration Units: HEPA primary and secondary filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 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.
 - 1. Locate facilities to limit site disturbance as specified in Division 01 Section 011000, "Summary."
- 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.

3.2 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.]
- 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.]
- 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. 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.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed in accordance with approved coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
 - 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- I. [Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.]
- J. [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 overhead, unless otherwise indicated.
 - 2. Connect temporary service to Owner's existing power source, as directed by Owner.]
- K. 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.

- L. Telephone:
 - 1. Post a list of important telephone numbers.
 - a. Police and fire departments
 - b. Ambulance service
 - c. Contractor's home office
 - d. Architect's office
 - e. Engineers' offices
 - f. Owner's office
 - g. Principal subcontractors' field and home offices
 - 2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30-feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 - 2. Maintain support facilities until Design Professional 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.
- B. Temporary Use of 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 sub-base and base for temporary roads and paved areas according to Division 31 Section [Insert Section number], "Earth Moving".
 - 3. Recondition base after temporary use, including removing contaminated material, re-grading, proof rolling, compacting, and testing.
- C. 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.
- D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- E. 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 nor endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- F. 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 touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Division 01 Section 017419, "Construction Waste Management and Disposal."
- H. 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.
- I. Temporary Elevator Use: Refer to Division 14 Sections for temporary use of new elevators.
- 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.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. 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.
 - 1. Comply with work restrictions specified in Division 01 Section 011000, "Summary."
- B. Temporary Erosion and Sedimentation Control: Comply with requirements of 2003 EPA Construction

- General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Division 31 Section [Insert Section number], "Site Clearing."
- 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. Tree and Plant Protection: Comply with requirements specified in Division 01 Section 015639, "Temporary Tree and Plant Protection."
 - E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
 - F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals 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. Furnish one set of keys to Owner.
 - G. 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.
 - H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
 - I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
 - J. 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 weather-tight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
 - K. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
 - 2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48-inches between doors. Maintain water-dampened foot mats in vestibule.
 - 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 4. Insulate partitions to control noise transmission to occupied areas.
 - 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 6. Protect air-handling equipment.
 - 7. Provide walk-off mats at each entrance through temporary partition.
 - L. 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.
 - 1. Prohibit smoking in construction areas.
 - 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.
- 3.5 MOISTURE CONTROL
- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
 - B. Exposed Construction Phase: 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 Phase: 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, replace or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
 - D. Controlled Construction Phase of Construction: 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 permanent HVAC system to control humidity.
 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 forty-eight (48) hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a forty-eight (48) hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to Design Professional.
 - c. Remove materials that can not be completely restored to their manufactured moisture level within forty-eight (48) hours.
 - E. Refer to Section 015300, Mold Prevention Measures, for additional requirements.
- 3.6 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 twenty-four (24) hour basis where required to achieve indicated results and to avoid possibility of damage.
 - C. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
 - D. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
 - E. 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. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section 017700, "Closeout Procedures."

END OF SECTION

SECTION 015300

MOLD PREVENTION MEASURES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- 1.2 SUMMARY
 - A. Section includes: Administrative and procedural requirements to help prevent mold contamination in construction. This section is in addition to requirements contained in Division 01 Section 015000, "Temporary Facilities and Controls".
- 1.3 SUBMITTALS
 - A. Reports: Submit reports required in this Section, including but not limited to the following:
 - 1. Sightings of existing mold
 - 2. Window and storefront testing
 - 3. Moisture contents of materials
 - 4. Exterior sealant cracks, damage, and deterioration
- 1.4 QUALITY ASSURANCE
 - A. Pre-construction Meeting: Review requirements of this Section at Pre-construction Meeting.
- 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
 - A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
 - B. Do not bring finish materials into building until building is in a conditioned state. Protect finish materials stored within building. Stage materials off the floor and cover with waterproof covering. Examples of these materials include, but are not limited to, insulation, gypsum products, wall coverings, carpet, ceiling tile, wood products, etc.
 - C. Remove from Project site damaged materials or materials that have become wet. Do not install such materials.
- 1.6 PROJECT CONDITIONS
 - A. Perform daily visual inspections of existing building for existing mold. Report sightings of mold to Architect.
 - B. Remove water found within building during construction immediately.
 - 1. Energize lift stations and sump pumps as early in Project as possible. Use temporary pumps if necessary to get water out of building and drain lines.
 - C. Ventilation:
 - 1. Verify that existing HVAC system is providing positive pressure in building.
 - 2. Provide adequate air circulation and ventilation during demolition phase(s).
 - 3. Seal off return air ducts and diffusers to prevent construction dust and moisture from entering occupied areas and HVAC system.
 - 4. Provide temporary outside air ventilation as building becomes enclosed.
 - D. Maintain clean project site, free from hazards, garbage, and debris.
 - E. Eating, drinking, and smoking are not permitted within building.
 - F. Slope perimeter grades, both temporary and final grades, away from building structure.
 - G. Verify that condensate pans drain properly beginning with initial installation.
 - H. Flash roof penetrations immediately. Do not allow water to penetrate to floor below.
 - I. Seal window openings prior to window installation with plastic to prevent moisture entry.
 - J. Sprayed-on Fireproofing: Keep air moving throughout building when using sprayed-on fireproofing.
 - K. Cover stored and installed ductwork and installed duct openings with plastic to prevent dust, debris, and moisture from entering ductwork. Repair damaged plastic barrier.
 - L. Do not operate air handling equipment below 60° F supply air temperature until building is 100 percent enclosed.
 - M. Monitor humidity and temperature for conformance to installation requirements defined by material and equipment manufacturers.
 - N. Check moisture content of gypsum board prior to applying finishes. Record findings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Roof Drains: Connect roof drains to risers and storm drainage lines as soon as possible.
- B. Floor Drains: Connect floor drains as soon as possible. Cover floor drains with tape during construction to keep construction debris from blocking drain. Clean out floor drain lines to mains prior to Substantial Completion.
- C. Wall Assemblies:
 - 1. Install exterior wall insulation, vapor retarder, and gypsum board only after building is enclosed.
 - 2. Keep bottom of installed gypsum board off floor ½ -inch.
- D. Cavity Conditions: Clean and inspect cavity conditions prior to covering, sealing, or restricting access. Vacuum-clean cavity spaces prior to covering or enclosing.
- E. Sprayed-On Fireproofing: Remove sprayed-on fireproofing overspray immediately.
- F. Plumbing: Pressure test plumbing piping identified as insulated on Project prior to installation of insulation.
- G. Roof Mounted Equipment: Inspect rooftop units and other roof-mounted equipment for signs of rain leaks immediately after first rain. Water test with hose immediately after installation. Seal leaks immediately.
- H. Windows and Storefront: Water test windows to manufacturer's and Project Manual's specifications. Record findings and forward to Architect.
- I. Sealants: Inspect exterior sealants for cracks, damage, or deterioration. Record findings and forward to Architect.
- J. HVAC Equipment (Permanent HVAC Equipment Used for Temporary Conditioning of Building During Construction Phases): Change filters and clean ductwork interior to remove dirt, dust, debris, and moisture buildup prior to turning Project over to Owner.

3.2 ADJUSTING

- A. Remove damaged materials or materials that have become wet. Replace with new materials.

3.3 DEMONSTRATION

- A. Train and educate Owner's maintenance personnel on use of building systems. Explain how improper operation and shutting down systems during off periods can create mold problems.
- B. Schedule with Owner a review of building for mold problems at 1-year warranty walk-through. Inspect exterior sealants and masonry joints for cracks and other damage or deterioration where water can penetrate building envelope.
- C. Explain to Owner the need for Owner to establish annual building review for mold.

END OF SECTION

SECTION 015639

TEMPORARY TREE AND PLANT PROTECTION

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 general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.3 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape at 6-inches above the ground for trees up to, and including, 4-inch size; and 12-inches above the ground for trees larger than 4-inch size.
- B. Plant Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- C. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of the following:
 - 1. Organic Mulch: 1-pint volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
 - 2. Protection Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
- C. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
 - 1. Species and size of tree
 - 2. Location on site plan. Include unique identifier for each.
 - 3. Reason for pruning
 - 4. Description of pruning to be performed
 - 5. Description of maintenance following pruning
- D. Qualification Data: For qualified arborist and tree service firm.
- E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- F. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes pre-construction conditions that might be misconstrued as damage caused by construction activities.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Pre-installation Conference: Will conduct conference at Pre-Construction Meeting.
 - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
 - b. Enforcing requirements for protection zones

- c. Arborist's responsibilities
- d. Field quality control

1.6 PROJECT CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material
 - 2. Parking vehicles or equipment
 - 3. Foot traffic
 - 4. Erection of sheds or structures
 - 5. Impoundment of water
 - 6. Excavation or other digging unless otherwise indicated
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, or gray than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other non-soil materials.
 - 1. Obtain topsoil only from well-drained sites where topsoil is 4-inches deep or more; do not obtain from bogs or marshes.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of the following:
 - 1. Type: Shredded hardwood, fully composted.
 - 2. Size Range: 3-inches maximum, ½ -inch minimum
 - 3. Color: Natural
- C. Protection Zone Fencing: Fencing fixed in position and meeting the following requirements (previously used materials may be used when approved by Architect):
 - 1. Protection Zone Fencing: 4' tall, heavy duty HDPE, high visibility orange, safety fencing, with rigid metal t-posts, minimum 6' tall installed 2' into the ground

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54-inches above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Tree Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
 - 1. Apply 3-inch average thickness of organic mulch. Do not place mulch within 6-inches of tree trunks.

3.3 TREE AND PLANT PROTECTION ZONES

- A. Protection Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
 - 1. Locate buried utilities and irrigation around trees and adjust tree protection fencing to miss utilities and maintain irrigation system as required before setting tree protection fencing.
 - 2. Safety Fencing: Install and maintain throughout the duration of construction.
 - 3. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
 - 4. Access Gates: Install as necessary; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Maintain protection zones free of weeds and trash.
- C. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner and time period approved by Architect.
- D. Maintain protection zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
 - 1. Do not remove protection zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 - 2. Temporary access is permitted subject to pre-approval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31 "Earth Moving".
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, air spade, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Where construction is required within the tree protection zone, provide 2"x4" wood barrier around the trunk of the tree. Replace barrier fencing as soon as possible after work in the tree protection zone is complete.
- D. Redirect roots in backfill areas where possible. If encountering large roots, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3-inches back from new construction and as required for root pruning.
- E. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction.
 - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Cut Ends: Coat cut ends of roots more than 1-inch in diameter with an approved root sealant.
 - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 4. Cover exposed roots with burlap and water regularly.
 - 5. Backfill as soon as possible.
 - 6. Root Pruning at Edge of Protection Zone: Prune roots 12-inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation

- B. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction.
 - 1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system at the direction of the Owner and Architect. Provide subsequent maintenance during Contract period as recommended by arborist.
 - 2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
 - a. Type of Pruning: Cleaning.
 - b. Specialty Pruning: Restoration.
 - 3. Cut branches with sharp pruning instruments; do not break or chop.
 - 4. Apply pruning paint to wounds.

3.7 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
 - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2-inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single un-compacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed root cutting and tree and shrub repairs.
 - 2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
 - 3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
 - 4. Perform repairs within 24 hours.
 - 5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches or smaller in caliper size.
 - 2. Provide one (1) new tree(s) of 6-inch caliper size for each tree being replaced that measure more than 6-inches in caliper size.
 - a. Species: Species selected by Architect.
 - 3. Plant and maintain new trees as specified in Division 32 "Landscape Planting".
- C. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36-inches to tree trunk. Use Air Spade Technology, 12-inches deep for aeration.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 015713

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes providing temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction. Temporary measures include the following:
 - 1. Silt fences and straw bales
 - 2. Sediment barriers and check dams
 - 3. Stabilized construction entrance
 - 4. Construction of temporary swales and sedimentation basins as required
 - 5. Seeding, sodding, and hydro mulching
- B. Comply with all local, state, and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System (NPDES) regulations from the Federal Clean Water Act.
- C. Should any provisions of this section be at variance with erosion control plan prepared by the civil engineer, the civil engineer's directive shall take precedence.

1.2 NOTICE OF INTENT

- A. Contractor shall submit an EPA Notice of Intent (NOI) prior to construction.
- B. Contractor shall prepare the report, coordinate with Owner, and file in accordance with regulations.

PART 2 - PRODUCTS

2.1 SILT FENCE

- A. Filter Fabric: Non-woven polypropylene, polyethylene or polyamide thermoplastic fibers with non-raveling edges. The fabric shall be non-biodegradable, inert to most soil chemicals, ultraviolet resistant, unaffected by moisture or other weather conditions, and permeable to water while retaining sediment. The filter fabric shall be supplied in rolls a minimum of 36-inches wide.
 - 1. Acceptable Products: Lundin "Silt Buster", Mirafi "Envirofence" or acceptable substitution.
- B. Wire Fence Support: Welded wire fabric 2 x 4 - W1.0 x W1.0.
- C. Fence Posts: Painted or galvanized steel Tee or Y-posts with anchor plates, not less than 5-feet in length with a minimum weight of 1.3 pounds per foot. Hangers shall be adequate to secure fence and fabric to posts. Posts and anchor plates shall conform to ASTM A-702.

2.2 STRAW BALES

- A. Standard rectangular straw bales bound by baling wire (NO TWINE).

2.3 SEDIMENT TRAPS

- A. Standard manufacture designed to fit the intended inlet.

2.4 STABILIZED CONSTRUCTION ENTRANCE

- A. Aggregate: Graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448 and TEX 401-A coarse-aggregate; with 0 percent being retained by a 5-inch sieve and 100 percent being retained by a 3-inch sieve.

2.5 GRASS

- A. Materials and seeding and sodding shall conform to applicable Division 32 section.

2.6 FERTILIZER

- A. Use commercial grade fertilizers to insure germination and growth. Analysis by weight shall be 16-4-8 or 15-5-10 for Nitrogen, Phosphoric Acid and Potash.

2.7 WATER

- A. Use clean potable water for maintaining the grass.

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep disturbed areas to a minimum required to adequately perform the work. At all times, maintain the site in such a manner that minimizes erosion of the site. The execution of work under this section shall be in conformance with the NPDES rulings and the site Storm Water Pollution Prevention Plan.

3.2 SILT FENCES

- A. Silt fence shall be a minimum of 24-inches high. Posts shall be embedded a minimum of 12-inches in the ground, placed a maximum of 8-feet apart and set on a slight angle toward the anticipated runoff source.
 - 1. When directed by the Engineer or designated representative, posts shall be set at specified intervals to support concentrated loads.
- B. Securely attach filter fabric to posts and wire support fence, with the bottom 12-inches of filter fabric buried in a trench a minimum of 6-inches deep and 6-inches wide to prevent sediment from passing under the fence.
 - 1. When silt fence is constructed on impervious material, a 12-inch flap of fabric shall be extended upstream from the bottom of the silt fence and weighted to limit particulate loss.
 - 2. No horizontal joints will be allowed in the filter fabric.
 - 3. Vertical joints shall be overlapped a minimum of 12-inches with the ends sewn or otherwise securely tied.
- C. Silt fence shall be maintained for the duration of the project, and repaired, replaced, and/or relocated when necessary or as directed by the Engineer or designated representative. Accumulated silt shall be removed when it reaches a depth of 6-inches

3.3 EROSION CONTROL BARRIERS

- A. Provide erosion control barriers at intervals along swales and ditches as shown on the Drawings or as necessary to meet the requirements of the Storm Water Pollution Prevention Plan.
- B. Barriers: Silt fence or straw bales placed as indicated on the Drawings.
- C. Maintain barriers in good working condition and replace when damaged.

3.4 STABILIZED CONSTRUCTION ENTRANCE

- A. Remove brush, stumps, obstructions, and other objectionable material and dispose of in a manner that will not interfere with the excavation, grading, and construction of the entrance as indicated on the Drawings.
 - 1. Stabilized construction entrance shall not drain onto the public right-of-way and shall not allow surface water runoff to exit the construction site.
 - 2. When necessary, vehicle wheels shall be cleaned to remove sediment prior to entrance onto public right-of-way.
 - a. When vehicle washing is required, it shall be done on an area stabilized with crushed stone, which drains into an approved sediment trap or sediment basin.
 - 3. Sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sand bags, gravel, boards, silt fence or other methods approved by the Engineer or designated representative.
- B. The entrance shall be maintained in a condition that will prevent tracking or disposition of sediment onto public right-of-way. Provide periodic top dressing with additional stone as conditions demand, as well as the repair and/or cleanout of any measures used to trap sediment. Sediment that is spilled, dropped, washed, or tracked onto public right-of-way shall be removed immediately.

3.5 TEMPORARY AND PERMANENT SWALES

- A. Description:
 - 1. Provide temporary and permanent drainage swales as required to carry drainage away from the work area to an approved outfall point.
 - 2. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least 2-feet deep with a slope of 0.1 percent.
 - 3. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.
 - 4. Swales shall have erosion control barriers as required.
 - 5. All permanent swales shall be sodded to a minimum width of 10-feet on either side of the centerline of the swale.

- B. Maintenance:
1. During the course of construction maintain temporary swales constructed for this contract so as to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, place temporary swales to remain in good working condition.
 2. Work with other contractors at the site in maintaining existing swales and ditches.
 3. Where necessary for access to the work areas install adequately sized culverts and maintain to provide the access without disturbing the site drainage.
 4. Take care not to rut and damage sodded swales. Immediately repair damaged swales.
 5. Keep sodded swales mowed.
- 3.6 DRAINAGE DITCHES
- A. Immediately hydro mulch drainage ditches upon final grading.
 - B. Repair erosion of the banks of the drainage ditches immediately and re-stabilize.
 - C. Place sediment barriers at intervals along the ditch as shown on the plans or as necessary to help trap sediment on the site. Remove sediment and other debris trapped by the barriers daily.
 - D. Maximum Ditch Side Slopes: 3-feet horizontal to 1-foot vertical.
 - E. Maintenance of the ditches during construction shall include but not be limited to mowing, re-grading, sediment removal, re-hydro mulching, bank repair, and debris removal.
 - F. Sediment removed from the ditches may be re-spread on the site as directed by the Owner.
- 3.7 FILL AND CUT SLOPES
- A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner's soils engineer.
 - B. When cut slopes exceed 2:1 for depths over 3-feet, proper bracing and shoring per OSHA requirements shall be used and maintained.
 - C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydro mulching, sodding, seeding, or other method as approved.
- 3.8 SEDIMENTATION BASINS
- A. Description:
 1. Provide sedimentation ponds where indicated.
 2. Route drainage from cleared areas through the sedimentation basin.
 3. Operate and maintain the pond during construction.
 - B. Maintenance:
 1. Maintain the pond and the outfall and sediment-retarding structure in good working condition throughout the time the pond is to be in operation.
 2. When sediment and debris fill the pond to over one third ($\frac{1}{3}$) its' designed capacity, clean out the pond.
 3. Stockpile, in its' own separate area, the sediment from the clearing operation, or remove from the site, as required. Make adequate drainage provisions such that drainage from the sediment stockpile drains back into the sediment pond. When approved by the Owner, sediment removed from the pond may be spread over the site.
- 3.9 SEEDING
- A. Seed disturbed portions of the site and stockpile areas within fourteen (14) days if the phasing of the construction operations is anticipated to leave those portions of the areas unworked for twenty-one (21) days or more.
 - B. Maintain seeded areas until the Owner accepts the project. Maintain by watering, fertilizing, reseeding, mowing and erosion repair as may be required. Cut grass when the average height of the grass reaches 4-inches. Clippings may be mulched back into the seeded areas.

END OF SECTION

SECTION 015720

INDOOR AIR QUALITY PLAN DURING CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements to develop and utilize an indoor air quality plan for the construction operation.
 - 2. A sample plan applicable to all interior construction and trades.
 - 3. Reference:
 - a. "IAQ Guidelines for Occupied Buildings under Construction", 2008 Edition, by the Sheet Metal and Air Conditioning Contractors National Association, Inc.

1.2 TRAINING

- A. Contractor shall provide copies of the plan and training to all subcontractors and appropriate personnel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXECUTION

- A. Contractor shall utilize a plan to protect the indoor environments from contamination during construction and finish out similar to the following plan.
- B. Contractor shall enforce and verify compliance by all personnel and subcontractors.
- C. Contractor shall take pictures of the related construction operations to verify conformance to each section of the plan. These pictures will be provided to the Architect. A minimum of eighteen (18) pictures (six (6) pictures taken on three (3) separate occasions) will be submitted.

3.2 INDOOR AIR QUALITY PLAN DURING CONSTRUCTION OPERATIONS

- A. Introduction
 - 1. This plan outlines the processes required to assure acceptable air quality. Elements of the program include:
 - a. HVAC Protection and Containing the work area
 - b. Source Control and Modifying HVAC Operation and Reducing Emissions
 - c. Pathway Interruptions
 - d. Intensifying Housekeeping
 - e. Scheduling or Relocation of Occupants

3.3 THESE REQUIREMENTS APPLY TO ALL PARTIES INVOLVED IN DESIGN, CONSTRUCTION, AND BUILDING MOVE IN:

- A. CONTAMINANTS
 - 1. Air contaminants include many different materials. These may include: gases, vapors, chemicals, mold/fungus, pathogens, allergens, particulates and radiation. Eliminating all of these is not possible but reducing the introduction and distribution of these contaminants is possible and desirable. The programs outlined in the following pages are intended to reduce contaminants and provide as clean a building as possible for the residents.
 - 2. The following sections outline procedures and precautions to reduce building contamination and meet the requirements for a healthy environment.
- B. CONSTRUCTION OPERATIONS
 - 1. HVAC PROTECTION: The air conditioning system is the distribution method for air and potential contaminants throughout the building. Keeping the system clean is a necessity.
 - a. All air handling equipment, spiral and fabricated ducts and accessories shall be kept clean during transportation, storage and assembly.
 - b. All lined, spiral and assembled ducts shall be wrapped and protected from dirt and water during transportation and storage.
 - c. All insulation and lined duct shall be kept dry at all times. Any insulation that has become wet shall be removed and replaced.

- d. Fiberglass duct board in the air handlers and bases shall be kept dry and clean. Exposed fiberglass subject to erosion shall be coated with a sealer to prevent the entry of raw fiberglass into the air stream.
 - 1) Water will not be allowed to stand on any mechanical equipment.
 - e. All open ends of installed duct and equipment shall be covered and sealed to prevent the entry of dirt.
 - f. All zone boxes shall be wrapped and sealed from dirt and water before installation. Installed zone boxes shall have the openings sealed until permanently connected to the ductwork.
 - g. All dampers and attenuators into open chases and ducts shall be covered to reduce dirt entry.
 - h. The air handlers shall not be started without MERV 8 filtration in place. Upon system activation, install sheet media on all return openings and filters in zone box plenum openings. These filters must be monitored and changed as necessary to prevent the entry of dirt into the system. The temporary media shall be removed after building flush out and before occupancy.
 - i. The return air system should not be used during sheet rock installation, sanding or painting operations.
 - j. The building should be kept under a positive pressure as much as possible.
 - k. Chase dampers shall be kept closed until the system is activated.
 - l. Complete the initial mechanical checklists at system startup.
 - m. Replace final filters with new filters before flush out or occupancy per design requirements.
2. SOURCE CONTROL
- a. No smoking or tobacco materials shall be allowed on all campuses.
 - b. No gasoline or fuel-fired equipment shall be used inside any enclosed building.
 - c. Wet processes within the building shall be kept to a minimum.
 - d. All chase and wallboard materials shall be protected from water. All damaged materials shall be removed and replaced.
 - e. Use low-emission materials and chemicals.
 - f. All cleaning involving chemicals shall be performed outside the building wherever possible.
 - g. All carpet materials shall be unrolled or unboxed and aired out in a well-ventilated warehouse for a minimum of three days before installation.
 - h. All modular furniture shall be aired out in a well-ventilated warehouse for seven days before entry into the building.
 - i. Trash shall be cleaned up and removed daily to the appropriate recycle container.
 - j. Any mold growth shall be treated according to the procedures shown in the New York City Department of Health "Guidelines on Assessment and Remediation of Fungi in Indoor Environments".
 - k. Clean the inside of all walls at the base track to remove excess materials and dirt with a vacuum cleaner before enclosing the wall. This is particularly critical on walls with plumbing or water piping included.
 - l. HEPA vacuum all concrete floors before installation of floor covering materials.
 - m. No obvious mold or chemical contamination shall be enclosed, hidden or painted.
3. PATHWAY INTERRUPTION
- a. Dust-producing operations shall be exhausted to the outside to the extent possible.
 - b. Exhaust fans may be installed on each floor to remove dust and contaminants.
 - c. The air handler shall supply conditioned air to the floors. Floors with heavy dust or chemical operations shall be exhausted to the outside.
 - d. During rain or high-humidity conditions, the air supply coming from the coils shall be cooled to 55° F or the air handler stopped to prevent moist air entry into the building. Exhaust fans shall not draw moist air into the building. It is preferable to have little airflow to moist air entering the building.
 - e. Return air dampers and openings shall be covered with filter media during operations that may contaminate the system.
 - f. During activities producing airborne particulates in occupied buildings undergoing renovation, or projects whose airspace is connected to occupied buildings, dust producing activities such as, but not limited to, demolition, sanding, buffing, and welding, the Contractor will provide commercial high volume air scrubbers at the rate of 1 per 7000 square feet, operate them continuously, and service them per the manufacturer, including high-efficiency particulate arrestance (HEPA) filter replacement.
4. HOUSEKEEPING
- a. Food or food residues shall be properly disposed after meals or breaks.
 - b. Once the building is enclosed with finishes applied, keep dirt entry to a minimum with walk off mats at all entrances. Clean the mats at least daily.

- c. All sweeping shall be done with dust reducing wax-based sweeping compounds.
 - d. All materials shall be kept clean and stored neatly on dunnage or pallets as required by the manufacturer.
 - e. Coils, fans, and air handler chambers, including return air chambers, shall be inspected and cleaned if required before start up, final testing and commissioning, and air testing.
 - f. All workers shall utilize the proper personal protective equipment per OSHA standards during any operation involving chemicals and dust production.
 - g. No food, drink, or smoking shall be allowed within the building after the building is enclosed.
5. SCHEDULING
- a. Complete all dust producing and chemical operations before the installation of "sink" materials such as carpet and ceiling tile.
 - b. Complete the HVAC control system sufficient to allow the operation of the supply and exhaust systems to control pressurization and contaminants.
 - c. Group contaminating operations where possible to maximize exhaust use.

END OF SECTION

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.

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, which 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 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 specific manufacturer's product is named and accompanied by the words "basis-of-design product", including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify 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. Design Professional's Action: If necessary, Design Professional will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Design Professional will notify Contractor of approval or rejection of proposed comparable product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Division 01 Section 013300, "Submittal Procedures".
 - b. Use product specified if Design Professional 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 Division 01 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.

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. Store 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. Refer to Divisions 02 through 49. Sections for specific content requirements and particular requirements for submitting special warranties.
 - C. Submittal Time: Comply with requirements in Division 01 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 not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected", Design Professional will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 - 6. Or Equal: For products specified by name and accompanied by the term "or equal", or "or approved equal", or "or approved", comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - B. Product Selection Procedures:
 - 1. 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.
 - 2. 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.

3. Products:
 - a. Restricted List: 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.
 - b. Non-restricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 4. Manufacturers:
 - a. Restricted List: 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 be considered, unless otherwise indicated.
 - b. Non-restricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 5. 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.
 - C. Visual Matching Specification: Where Specifications require "match Design Professional's sample", provide a product that complies with requirements and matches Design Professional's sample. Design Professional'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 Division 01 Section 012500, "Substitution Procedures" for proposal of product.
 - D. Visual Selection Specification: Where Specifications include the phrase "as selected by Design Professional from manufacturer's full range" or similar phrase, select a product that complies with requirements. Design Professional 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: Design Professional will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Design Professional may return requests without action, except to record noncompliance with these requirements:
 1. Evidence that the proposed product does not require revisions to the Contract Documents, it is consistent with the Contract Documents, will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of Design Professionals and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 017300

EXECUTION

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 general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout
 - 2. Field engineering and surveying
 - 3. Installation of the Work
 - 4. Cutting and patching
 - 5. Coordination of Owner installed products
 - 6. Progress cleaning
 - 7. Starting and adjusting
 - 8. Protection of installed construction
 - 9. Correction of the Work

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- C. Certified Surveys: Submit two (2) paper copies that are certified, sealed and signed by a Texas registered professional land surveyor. Also submit one copy of the survey in CAD format using surface coordinates and one copy of the survey in CAD format using grid coordinates. Coordinate with Owner for the reference coordinate system and CAD guidelines.
- D. Final Property Survey: Submit one (1) digital copy that is certified, sealed and signed by a Texas registered professional land surveyor showing the Work performed. Also submit one copy of the survey in CAD format using surface coordinates and one copy of the survey in CAD format using grid coordinates. Coordinate with Owner for the reference coordinate system and CAD guidelines.

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. 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, notify Design Professional of locations and details of cutting and await directions from the Design Professional before proceeding. Shore, brace, and support structural element 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 result in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment
 - b. Fire separation assemblies
 - c. Air or smoke barriers
 - d. Fire-suppression systems
 - e. Mechanical systems piping and ducts
 - f. Control systems
 - g. Communication systems
 - h. Conveying systems
 - i. Electrical wiring systems

- j. Operating systems of special construction
 - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, which results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers
 - b. Membranes and flashings
 - c. Exterior curtain-wall construction
 - d. Equipment supports
 - e. Piping, ductwork, vessels, and equipment
 - f. Noise- and vibration-control elements and systems
 - 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 Design Professional's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
 - C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
 - D. Manufacturer's Installation Instructions: Obtain and maintain onsite manufacturer's written recommendations and instructions for installation of products and equipment.
- 1.6 WARRANTY
- A. 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.

PART 2 - PRODUCTS

- 2.1 MATERIALS
- A. General: Comply with requirements specified in other Sections.
 - 1. For projects requiring compliance with sustainable design and construction practices and procedures, utilize products for patching that comply with requirements of Division 01 Section 018114, "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 the Design Professional for the visual and functional performance of in-place materials.

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 site work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work. Surveyor will perform a Locative Survey (Category 3) according to the standards set by the Texas Society of Professional Surveyors Manual of Practice.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, 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.
 - 3. Collect and depict all utility infrastructure according to the Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data published by the American Society of Civil Engineers, publication number CI/ASCE 38-02. All utility data must have a quality level clearly associated, either via a geospatial database, CAD layering, plan symbols, and/or plan labels per the guidelines. Design Professional or Engineer will work with Owner to explain and detail costs and benefits so as to achieve the highest quality levels of subsurface utility engineering applicable to the Project and Work.
 - 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 indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is

required by other Sections, include the following:

- a. Description of the Work
 - b. List of detrimental conditions, including substrates
 - c. List of unacceptable installation tolerances
 - d. Recommended corrections
2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 5. 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 caused by differing field conditions outside the control of the Contractor, submit a request for information to Design Professional according to requirements in Division 01 Section 013100, "Project Management and Coordination".

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. If discrepancies are discovered, notify Design Professional promptly.
- B. General: Engage a land surveyor to lay out the Work using 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 dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 3. Inform installers of lines and levels to which they must comply.
 4. Check the location, level, and plumb of every major element as the Work progresses.
 5. Notify Design Professional when deviations from required lines and levels exceed allowable tolerances.
 6. 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 Design Professional.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 1. Do not change or relocate existing benchmarks or control points without prior written approval of Owner and Design Professional. Report lost or destroyed permanent benchmarks or control points

- promptly. Report the need to relocate permanent benchmarks or control points to Design Professional before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish, construct and maintain a minimum of two permanent benchmarks on Project site, referenced to Owner's established geographic coordinate system. Benchmarks will function as both horizontal and vertical benchmarks. A registered professional land surveyor must establish the new benchmarks to meet specifications of National Geodetic Survey (NGS) Class RT1 surveys per the latest version of the User Guidelines for Single Base Real Time GNSS Positioning publication. New and re-set benchmarks will comply with the guidelines specified by Appendix B of the Bench Mark Reset Procedures document published by the NGS agency.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Mapping As-built Conditions: Once inspected and approved by Owner, all underground utility locations will be mapped using GPS mapping equipment to decimeter precision or better, prior to backfill, to collect geospatial data on as-built conditions. Any work covered prior to mapping will be required to be uncovered at no cost or schedule impact to the project. Consult with Owner for guidelines on how to collect the geospatial data and what information needs to be recorded about each utility feature. This information will be incorporated into the project record drawings to indicate the horizontal and vertical location of facilities, easements and improvements, as built.

3.5 INSTALLATION

- A. General: 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.
- 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 the best possible results. 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.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory-prepared and field-installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. 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.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Design Professional.
 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.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, 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. Temporary Support: Provide temporary support of work to be cut.
- C. 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.

- D. 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 of Division 01 Section 011000, "Summary".
 - E. 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 prevent interruption to occupied areas.
 - F. 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 and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Division 31 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.
 - G. 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. 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 minimize 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. Provide additional coats until patch blends with adjacent surfaces.
 - 4. Ceilings: Patch, repair, or re-hang 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 weather-tight condition.
 - H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.
- 3.7 OWNER-INSTALLED PRODUCTS
- A. Site Access: Provide access to Project site for Owner's construction personnel.
 - B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
 - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.
- 3.8 PROGRESS CLEANING
- A. General: 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 (7) days during normal weather or three (3) days if the temperature is expected to rise above 80° F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Utilize containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where more than one installer has worked.
- 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 in Finished Areas: 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 Division 01 Section 015000, "Temporary Facilities and Controls" and Division 01 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 assure that no part of the construction completed or in progress is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 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 Division 01 Section 014000, "Quality Requirements".

3.10 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. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. 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. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

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. Salvaging non-hazardous demolition and construction waste
 - 2. Recycling non-hazardous demolition and construction waste
 - 3. Disposing of non-hazardous 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.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling a minimum of seventy-five percent (75%) by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:
 - 1. Demolition Waste:
 - a. Concrete
 - b. Concrete reinforcing steel
 - c. Brick
 - d. Concrete masonry units
 - e. Doors and frames
 - f. Door hardware
 - g. Metal studs
 - h. Gypsum board
 - i. Acoustical tile and panels
 - j. Carpet
 - k. Carpet pad
 - l. Plumbing fixtures
 - m. Piping
 - n. Mechanical equipment
 - o. Refrigerants
 - p. Electrical conduit
 - q. Copper wiring
 - r. Lighting fixtures
 - s. Switchgear and panelboards
 - t. Transformers
 - 2. Construction Waste:
 - a. Site-clearing waste
 - b. Masonry and CMU
 - c. Lumber
 - d. Wood sheet materials
 - e. Wood trim

- f. Metals
- g. Carpet and pad
- h. Gypsum board
- i. Piping
- j. Electrical conduit
- k. Packaging: Regardless of salvage/recycle goal indicated in paragraph above, salvage or recycle one-hundred percent (100%) of the following uncontaminated packaging materials:
 - 1) Paper
 - 2) Cardboard
 - 3) Boxes
 - 4) Plastic sheet and film
 - 5) Polystyrene packaging
 - 6) Wood crates
 - 7) Plastic pails

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within thirty (30) days of date established for commencement of the Work.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with LEED Submittal. Include the following information:
 - 1. Material category
 - 2. Generation point of waste
 - 3. Total quantity of waste in tons
 - 4. Quantity of waste salvaged, both estimated and actual in tons
 - 5. Quantity of waste recycled, both estimated and actual in tons
 - 6. Total quantity of waste recovered (salvaged plus recycled) in tons
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- E. LEED Submittal: LEED letter template for Credit MRc5, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
- F. Qualification Data: For waste management coordinator refrigerant recovery technician.
- G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of Projects with similar requirements.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section 013100, "Project Management and Coordination". Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements of this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site clearing, and construction waste generated by the Work. Use attached form or comparable generated by Contractor. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan.

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.
 - 1. Comply with Division 01 Section 015000, "Temporary Facilities and Controls" for operation, termination, and removal requirements.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. 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 Division 01 Section 015000, "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: NOT Permitted on Project site.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

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 designated by Owner.
 5. Protect items from damage during transport and storage.
 - D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
 - E. Plumbing Fixtures: Separate by type and size.
 - F. Lighting Fixtures: Separate lamps by type and protect from breakage.
- 3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL
- A. General: Recycle paper and beverage containers used by on-site workers.
 - B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
 - C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
 - D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 4. Store components off the ground and protect from the weather.
 5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.
- 3.4 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. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - B. Burning: Do not burn waste materials.
 - C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

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

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver attic stock and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 8. Complete startup testing of systems.
 - 9. Submit test/adjust/balance records.
 - 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 11. Advise Owner of changeover in heat and other utilities.
 - 12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 - 13. Complete final cleaning requirements, including touchup painting.
 - 14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. 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. Re-inspection: 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.

1.4 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
 - 1. Submit a final Application for Payment according to Division 01 Section 012900, "Payment Procedures".
 - 2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 - 4. Submit pest-control final inspection report and warranty.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 - B. Inspection: Submit a written request for final inspection for acceptance. 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.
 1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected. Include cost for re-inspection based on incomplete work of the Contractor.
- 1.5 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. Use CSI Form 14.1A attached or form provide by Contractor and approved by Owner and Architect.
 1. Organize list of spaces in sequential order, starting with exterior areas first.
 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. PDF electronic file
 - b. ~~Three (3) paper copies of product schedule or list, unless otherwise indicated. Architect will return two (2) copies.~~
- 1.6 WARRANTIES
- A. Submittal Time: Submit written warranties for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
 - B. Partial Occupancy: Submit properly executed warranties within fifteen (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 the Project Manual.
 1. ~~Bind warranties and bonds in heavy duty, three ring, vinyl covered, loose leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½ by 11-inch paper.~~
 2. ~~Provide heavy paper dividers with plastic covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.~~
 3. ~~Identify each binder on the front and spine with the typed or printed title "WARRANTIES", Project name, and name of Contractor.~~
 4. ~~Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.~~
 - D. Provide additional copies of each warranty to include in operation and maintenance manuals. ~~Included digital copies of each warranty within appropriate division of operations and maintenance manuals.~~
 - E. After final assembly, scan entire warranty binder into PDF format and deliver to Owner. ~~Deliver entire closeout package to owner in PDF format on a thumb drive.~~

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.
 1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

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 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 clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor 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 clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo 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. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter upon inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard ACR-2013.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section 017419, "Construction Waste Management and Disposal".

END OF SECTION

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
 - 2. Emergency manuals
 - 3. Operation manuals for systems, subsystems, and equipment
 - 4. Product maintenance manuals
 - 5. Systems and equipment 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. Manual Content: Operations and maintenance manual content is specified in individual specification sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Where applicable, clarify and update reviewed manual content to correspond to modifications and field conditions.
 - B. Format: Submit operations and maintenance manuals in the following format:
 - a. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Design Professional.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - b. One (1) paper copy. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Design Professional will return.
 - C. Initial Manual Submittal: Submit draft copy of each manual to Owner and Design Professional at least thirty (30) days before commencing demonstration and training. Design Professional, Owner, and Commissioning Agent will comment on whether general scope and content of manual are acceptable.
 - D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) days before commencing demonstration and training. Design Professional and Commissioning Agent will return copy with comments.
 - 1. Correct or modify each manual to comply with Design Professional's and Commissioning Agent's comments. Submit copies of each corrected manual within fifteen (15) days of receipt of Design Professional's and Commissioning Agent's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

- 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY
 - A. Organization: Include a section in the directory for each of the following:
 - 1. List of documents
 - 2. List of systems
 - 3. List of equipment
 - 4. Table of contents
 - B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 - C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of a system, list alphabetically in separate list.
 - D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4-2008, "Preparation of Operating and Maintenance Documentation for Building Systems".

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page
 - 2. Table of contents
 - 3. Manual contents
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual
 - 2. Name and address of Project
 - 3. Name and address of Owner
 - 4. Date of submittal
 - 5. Name and contact information for Contractor
 - 6. Name and contact information for Construction Manager
 - 7. Name and contact information for Design Professional
 - 8. Name and contact information for Commissioning Agent
 - 9. Names and contact information for major consultants to the Design Professional that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic 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. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily-navigated file tree. Configure electronic manual to display bookmark panel upon opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound, and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf or post-type binders, in thickness necessary to accommodate contents, sized to hold 8½ by 11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two (2) or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL", Project title or name and subject matter of contents. Indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
 - 4. Supplementary Text: Prepared on 8½ by 11-inch white bond paper.
 - 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as

foldouts.

- b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
 - 1. Type of emergency
 - 2. Emergency instructions
 - 3. Emergency procedures
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Fire
 - 2. Flood
 - 3. Gas leak
 - 4. Water leak
 - 5. Power failure
 - 6. Water outage
 - 7. System, subsystem, or equipment failure
 - 8. Chemical release or spill
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
 - 1. Instructions on stopping
 - 2. Shutdown instructions for each type of emergency
 - 3. Operating instructions for conditions outside normal operating limits
 - 4. Required sequences for electric or electronic systems
 - 5. Special operating instructions and procedures

2.4 OPERATION MANUALS

- A. 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 is 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
- B. 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
- C. 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
 - D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
 - E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.
- 2.5 PRODUCT MAINTENANCE MANUALS
- A. 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.
 - B. 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.
 - C. 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
 - D. 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
 - E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
 - F. 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
- 2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS
- A. Content: For each system, subsystem, 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 warranty and bond information, as described below.
 - B. Source Information: List each system, subsystem, and piece of equipment 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.
 - C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins
 - 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
 - D. 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
 - E. 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.

- F. 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.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- 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.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION AND DELIVERY

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 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.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, 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.
 - 1. 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.
- F. 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 operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared record Drawings in Division 01 Section 017839, "Project Record Documents".
- G. Comply with Division 01 Section 017700, "Closeout Procedures" for schedule for submitting operation and maintenance documentation.
- H. Include transmittal with all deliveries to Owner. Request receipt confirmation.

END OF SECTION

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
- 1.3 DEFINITIONS
 - A. Geospatial Data: Data or information that identifies the geographic location of features and boundaries in relation to the Owner's coordinate system.
- 1.4 CLOSEOUT SUBMITTALS
 - A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal: Submit one (1) paper copy and PDF electronic files of marked-up record prints and one (1) set of plots from corrected record digital data files. Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal: Submit one (1) paper copy, PDF electronic files, CADD and BIM of marked-up record prints, one (1) set of record digital data files, and three (3) sets of record digital data file plots. Plot each drawing file, whether or not changes and additional information were recorded.
 - c. Architect will amend record CADD files for submission to Owner at completion of project.
 - B. Record Specifications: Submit one (1) paper copy and one (1) PDF copy of Project's Specifications, including addenda and contract modifications.
 - C. Record Product Data: Submit one (1) paper copy, one (1) PDF copy of each submittal, and one (1) CoBIE format.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
 - D. Miscellaneous Record Submittals: Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one (1) paper copy of each submittal.
 - E. Reports: Submit written report indicating items incorporated in Project record documents concurrent with progress of the Work, including modifications, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

- 2.1 RECORD DRAWINGS
 - A. Record Prints: Maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings.
 - 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 archive 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 below first floor
 - 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. Utilize 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: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Format: As approved by Owner.
 3. Format: Annotated PDF electronic file with comment function enabled.
 4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 5. Refer instances of uncertainty to Architect through Construction Manager for resolution.
 6. Incorporate geospatial data collected during construction and installation to more accurately reflect as-built conditions.
 - C. Newly-Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult Architect and Construction Manager for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
 - D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize record prints and newly prepared record Drawings 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.
 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 and Construction Manager
 - e. Name of Contractor
- 2.2 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. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as a scanned PDF electronic file of the marked up paper copy of Specifications.
- 2.3 RECORD PRODUCT DATA
- A. 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.
- B. Format: Submit record Specifications as a scanned PDF electronic file and CoBIE format of the marked up paper copy of Specifications.
1. Include record Product Data directory organized by specification section number and title, electronically linked to each item of record Product Data.
- 2.4 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 record Specifications as a scanned PDF electronic file of the marked up paper copy of Specifications.
1. Include miscellaneous record submittals directory organized by specification section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

- 3.1 RECORDING AND MAINTENANCE
- A. Recording: Maintain one (1) copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples 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 and Construction Manager's reference during normal working hours.

END OF SECTION

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. Demonstration of operation of systems, subsystems, and equipment
 - 2. Training in operation and maintenance of systems, subsystems, and equipment
- B. Related Sections:
 - 1. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections

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 utilizing 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 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 Division 01 Section 014000, "Quality Requirements", experienced in operation and maintenance procedures and training.
- C. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Division 01 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.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- 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 has been reviewed and approved by Design Professional.

PART 2 - PRODUCTS

2.1 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. Operations manuals
 - c. Maintenance manuals
 - d. Project record documents
 - e. Identification systems
 - f. Warranties and bonds
 - g. 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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section 017823, "Operations and Maintenance Data".
- B. Set up instructional equipment at instruction location.

3.2 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.
- 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, through Construction Manager, with at least seven days' advance notice.
- D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- E. 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.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified individual to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.
 1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
 2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
 3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
 - a. Name of Contractor/Installer
 - b. Business address
 - c. Business phone number
 - d. Point of contact
 - e. E-mail address
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
 1. Film training session(s) in segments not to exceed fifteen (15) minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds fifteen (15) minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 - 1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Pre-produced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION

SECTION 018114

SUSTAINABLE DESIGN 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 general requirements and procedures for compliance with USGBC LEED prerequisites and credits needed for Project to obtain LEED certification based on LEED **[Level]** certification based on **[LEED Version]**. Other LEED prerequisites and credits needed to obtain LEED certification depend on material selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 1. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Design Professional's design and other aspects of Project that are not part of the Work of the Contract.
 - 2. A copy of the LEED Project checklist is attached at the end of this Section for information only.
- B. Related Sections:
 - 1. Divisions 01 through 33 Sections for requirements specific to the work of each of these Sections.

1.3 DEFINITIONS

- A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship". Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- B. LEED: Leadership in Energy & Environmental Design.
- C. Rapidly Renewable Materials: Materials made from plants that are typically harvested within a 10-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.
- D. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
- E. Regionally-Manufactured Materials: Materials that are manufactured within a radius of 500 miles from Project site. Manufacturing refers to the final assembly of components into the building product that is installed at Project site.
- F. Regionally-Extracted and Manufactured Materials: Regionally-manufactured materials made from raw materials that are extracted, harvested, or recovered within a radius of 500 miles from Project site.
- G. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
 - 1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- H. Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
 - 1. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.
 - 2. Discarded materials from one manufacturing process that are used as constituents in another manufacturing process are pre-consumer recycled materials.

1.4 SUBMITTALS

- A. General: Submit sustainable submittals required by other Specification Sections.

- B. Sustainable submittals are to be submitted with other submittals required by each section. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated sustainable requirements.
- C. Project Materials Cost Data: Provide statement indicating total cost for building materials used for Project, excluding mechanical, electrical, and plumbing components, and specialty items such as elevators and equipment. Include statement indicating total cost for wood-based materials used for Project.
- D. Sustainable Action Plans: Provide preliminary submittals within fourteen (14) days of date established for commencement of the Work indicating how the following requirements will be met:
 - 1. Waste management plan complying with Division 01 Section 017419, "Construction Waste Management and Disposal".
 - 2. Recycled Content: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
 - 3. Regional Materials: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 - 4. Certified Wood: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
 - 5. Indoor Air Quality: Construction indoor-air-quality management plan.
- E. Sustainable Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with action plans for the following:
 - 1. Waste reduction progress reports complying with Division 01 Section 017419, "Construction Waste Management and Disposal".
 - 2. Recycled content
 - 3. Regional materials
 - 4. Certified wood products
- F. Sustainable Documentation Submittals:
 - 1. Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy consumption performance over time.
 - 2. Recycled Content: Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
 - 3. Regional Material: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
 - 4. Certified Wood: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 - 5. Indoor Air Quality During Construction:
 - a. Construction indoor air quality management plan
 - b. Product data for temporary filtration media
 - c. Product data for filtration media used during occupancy
 - d. Construction Documentation: Six (6) photographs at three (3) different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor air quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
 - 6. Indoor Air Quality Prior to Occupancy:
 - a. Signed statement describing the building air flush-out procedures, including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
 - b. Product data for filtration media used during flush-out and during occupancy.
 - c. Report from testing and inspecting agency, indicating results of indoor air quality testing and documentation shows compliance with indoor air quality testing procedures and requirements.
 - 7. Adhesives and Sealants: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 8. Paints and Coatings: Product data for paints and coatings used inside the weatherproofing system indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 9. Urea Formaldehyde Prohibition: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

- 1.5 QUALITY ASSURANCE
- A. Sustainability Coordinator: Engage an experienced LEED-Accredited Professional to coordinate sustainable requirements. Sustainability Coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

- 2.1 RECYCLED CONTENT OF MATERIALS
- A. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
- B. Do not include mechanical and electrical components in the calculation.
- 2.2 REGIONAL MATERIALS
- A. Provide 20 percent of building materials (by cost) that are regional materials.
- B. Provide 20 percent of building materials (by cost) that are regionally manufactured materials.
- C. Provide 10 percent of building materials (by cost) that are regionally extracted and manufactured materials.
- 2.3 CERTIFIED WOOD
- A. Provide a minimum of 50 percent (by cost) of wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship".
1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
- a. Rough carpentry
 - b. Miscellaneous carpentry
 - c. Heavy-timber construction
 - d. Wood decking
 - e. Metal plate-connected wood trusses
 - f. Structural glued-laminated timber
 - g. Finish carpentry
 - h. Architectural woodwork
 - i. Wood paneling
 - j. Wood veneer wall covering
 - k. Wood flooring
 - l. Wood lockers
 - m. Wood cabinets
 - n. Furniture
- 2.4 LOW-EMITTING MATERIALS
- A. For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
- 1. Wood Glues: 30 g/L
 - 2. Metal-to-Metal Adhesives: 30 g/L
 - 3. Adhesives for Porous Materials (Except Wood): 50 g/L
 - 4. Subfloor Adhesives: 50 g/L
 - 5. Plastic Foam Adhesives: 50 g/L
 - 6. Carpet Adhesives: 50 g/L
 - 7. Carpet Pad Adhesives: 50 g/L
 - 8. VCT and Asphalt Tile Adhesives: 50 g/L
 - 9. Cove Base Adhesives: 50 g/L
 - 10. Gypsum Board and Panel Adhesives: 50 g/L
 - 11. Rubber Floor Adhesives: 60 g/L
 - 12. Ceramic Tile Adhesives: 65 g/L
 - 13. Multipurpose Construction Adhesives: 70 g/L
 - 14. Fiberglass Adhesives: 80 g/L
 - 15. Contact Adhesive: 80 g/L
 - 16. Structural Glazing Adhesives: 100 g/L
 - 17. Wood Flooring Adhesive: 100 g/L
 - 18. Structural Wood Member Adhesive: 140 g/L

19. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
 20. Top and Trim Adhesive: 250 g/L
 21. Plastic Cement Welding Compounds: 350 g/L
 22. ABS Welding Compounds: 400 g/L
 23. CPVC Welding Compounds: 490 g/L
 24. PVC Welding Compounds: 510 g/L
 25. Adhesive Primer for Plastic: 650 g/L
 26. Sheet Applied Rubber Lining Adhesive: 850 g/L
 27. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight
 28. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight
 29. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight
 30. Other Adhesives: 250 g/L
 31. Architectural Sealants: 250 g/L
 32. Non-Membrane Roof Sealants: 300 g/L
 33. Single-Ply Roof Membrane Sealants: 450 g/L
 34. Other Sealants: 420 g/L
 35. Sealant Primers for Nonporous Substrates: 250 g/L
 36. Sealant Primers for Porous Substrates: 775 g/L
 37. Modified Bituminous Sealant Primers: 500 g/L
 38. Other Sealant Primers: 750 g/L
- B. For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L
 2. Non-Flat Paints, Coatings, and Primers: VOC not more than 150 g/L
 3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L
 4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L
 5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L
 6. Floor Coatings: VOC not more than 100 g/L
 7. Shellacs, Clear: VOC not more than 730 g/L.
 8. Shellacs, Pigmented: VOC not more than 550 g/L
 9. Stains: VOC not more than 250 g/L
 10. Flat Interior Topcoat Paints: VOC not more than 50 g/L
 11. Non-Flat Interior Topcoat Paints: VOC not more than 150 g/L
 12. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L
 13. Clear Wood Finishes, Varnishes and Sanding Sealers: VOC not more than 350 g/L
 14. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L
 15. Floor Coatings: VOC not more than 100 g/L
 16. Shellacs, Clear: VOC not more than 730 g/L
 17. Shellacs, Pigmented: VOC not more than 550 g/L
 18. Stains: VOC not more than 250 g/L
 19. Primers, Sealers, and Undercoats: VOC not more than 200 g/L
 20. Dry-Fog Coatings: VOC not more than 400 g/L
 21. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L
 22. Pretreatment Wash Primers: VOC not more than 420 g/L
 23. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
- C. Urea Formaldehyde Prohibition: Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

- A. Remove CFC-based refrigerants from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC-based. Replace or adjust existing equipment to accommodate new refrigerant as described in Division 23 Section **[Number]** **[Title]**.
- B. Remove clean-agent fire-extinguishing agents that contain HCFCs or halons and replace with agent that does not contain HCFCs or halons. See Division 21 Section **[Number]**, "Clean-Agent Fire Extinguishing Systems" for additional requirements.

3.2 MEASUREMENT AND VERIFICATION

- A. Implement measurement and verification plan consistent with [Option B: Energy Conservation Measure Isolation] [Option D: Calibrated Simulation, Savings Estimation Method 2] in the EVO's "International Performance Measurement and Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction".
- B. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
- C. Evaluate energy performance and efficiency by comparing actual to predicted performance.
- D. Measurement and verification period shall cover at least one year of post-construction occupancy.

3.3 CONSTRUCTION WASTE MANAGEMENT

- A. Comply with Division 01 Section 015639, "Construction Waste Management and Disposal".

3.4 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction".
 - 1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls", install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
 - 2. Replace all air filters immediately prior to occupancy.
- B. Comply with the following requirements:
 - 1. Air-Quality Testing:
 - a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air" and as additionally detailed in the USGBC's **[LEED Version]**: Reference Guide".
 - b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - 1) Formaldehyde: 50 ppb
 - 2) Particulates (PM10): 50 micrograms/cu. m
 - 3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m
 - 4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m
 - 5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels
 - c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting non-complying building areas, take samples from same locations as in the first test.
 - d. Air-sample testing shall be conducted as follows:
 - 1) All measurements shall be conducted prior to occupancy but during normal occupied hours and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
 - 2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Non-fixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
 - 3) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
 - 4) Air samples shall be collected between 3-feet and 6-feet from the floor to represent the breathing zone of occupants, and over a minimum four (4) hour period.

END OF SECTION

SECTION 019113

GENERAL COMMISSIONING 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.
- B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

1.3 DEFINITIONS

- A. BoD: Basis of Design. A document 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 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 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.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. 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: The designated person, company, or entity that 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 Design Professional, CxA and Contractor for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BoD documentation, prepared by Design Professional and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall 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 the Issues Log.
 - 3. Attend commissioning team meetings held on a monthly basis.
 - 4. Integrate and coordinate commissioning process activities with construction schedule.
 - 5. Review and accept construction checklists provided by the CxA.
 - 6. Complete electronic construction checklists as Work is completed and provide to the CxA.
 - 7. Review and accept commissioning process test procedures provided by the CxA.

8. Complete commissioning process test procedures.
-
- 1.7 CxA'S 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, the CxA will report the failure in the Issues Log.
 - F. Prepare and maintain the 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; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 02 4119 SELECTIVE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

- A. The Work of this Section Includes:
 - 1. Demolition and removal of selected portions of exterior or interior of building or structure and site elements.
 - 2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.
- B. Related Requirements:
 - 1. Section 011000 "Summary of Work" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 017300 "Execution" for cutting and patching procedures.
 - 3. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.

1.02 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.
- 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: Existing items of construction that are not to be removed.

1.03 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.04 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.05 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of 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.
 - 6. Review and finalize protection requirements.
 - 7. Review procedures for noise control and dust control.
 - 8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For refrigerant recovery technician.

- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property and for dust 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. Temporary interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.
- E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.07 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.08 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.09 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- 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:
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials:
 - 1. It is not expected that hazardous materials will be encountered in the Work.
 - a. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
 - b. Owner will provide material safety data sheets for hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- E. On-site sale of removed items or materials is not permitted.

PART 2 PRODUCTS

2.01 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.

PART 3 EXECUTION

3.01 EXAMINATION

- A. 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.
- B. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- C. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video. Comply with Section 013233 "Photographic Documentation."
 - 1. Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or video conditions that might be misconstrued as damage caused by removal.
 - 2. Photograph or video existing conditions of adjoining construction including finish surfaces, that might be misconstrued as damage caused by selective demolition operations or removal of items for salvage or reinstallation.

3.02 PREPARATION

- A. 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.
- B. 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. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 3. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 4. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location[and cleaned] and reinstalled in their original locations after selective demolition operations are complete.
- D. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.

3.03 UTILITY SERVICES AND BUILDING SYSTEMS

- A. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.
 - 1. Arrange to shut off utilities with utility companies in coordination with Owner.
 - 2. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
 - 3. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

- b. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- 4. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.
 - a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.
- 5. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:
 - a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.
 - b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.

3.04 SALVAGE/REINSTALL

- A. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.
- B. 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.

3.05 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. 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.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. 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.
 - 4. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 - 5. Maintain adequate ventilation when using cutting torches.
 - 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

- 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.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.

3.06 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete:
 - 1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- D. Resilient Floor Coverings: Remove floor coverings and adhesive in accordance with recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

3.07 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."
 - 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. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

3.08 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

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SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings and grade-supported slabs.
 - 2. Slabs on metal deck.
- B. WORK INCLUDED
 - 1. Design, fabrication, erection, and stripping of formwork for cast-in-place concrete including shoring, reshoring, falsework, bracing, proprietary forming systems, prefabricated forms, void forms, permanent metal forms, bulkheads, keys, blockouts, sleeves, pockets, and accessories. Erection shall include installation in formwork of items furnished by other trades.
 - 2. Furnish all labor and materials required to fabricate, deliver and install reinforcement and embedded metal assemblies for cast-in-place concrete, including steel bars, welded steel wire fabric, ties and supports.
 - 3. Furnish all labor and materials required to perform the following:
 - a. Cast-in-place concrete
 - b. Concrete mix designs
 - c. Grouting structural steel baseplates

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, Slag Cement, and silica fume; subject to compliance with requirements.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture, submit proposed mix designs in accordance with ACI 318 requirements. Each proposed mix design shall be accompanied by a record of past performance.
 - 1. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 2. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - 1. Do not reproduce the structural drawings for use as shop drawings.
 - 2. Embedded metal assemblies: Submit shop drawings for fabrication and placement. Use standard AWS welding symbols.
- D. Steel Reinforcement Submittals for Information: Mill test certificates of supplied concrete reinforcing, indicating physical and chemical analysis.
- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates.
- F. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials
 2. Admixtures
 3. Form materials and form-release agents
 4. Steel reinforcement and accessories
 5. Curing compounds
 6. Floor and slab treatments
 7. Bonding agents
 8. Adhesives
 9. Joint-filler strips
 10. Repair materials
- G. Submit manufacturer's certification of maximum chloride ion content in admixtures.
- H. Fly ash: Submit certification attesting to carbon content and compliance with ASTM C618.
- I. Construction Joint Layout: Submit a diagram of proposed construction joint locations for horizontal framing that exceed the limits of a single placement as stated in the structural notes, other than those indicated on the Drawings.
- J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
- K. Field quality-control test and inspection reports.
- L. Minutes of preinstallation conference.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-- Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete,"
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Owner may engage a qualified independent testing agency to perform material evaluation tests.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures,

curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Store all proprietary materials in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301 (ACI 301M).
 - 2. ACI 117 (ACI 117M).

2.02 FORM-FACING MATERIALS

- A. 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.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4-inch, minimum.
- C. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT

- A. Source of Steel Producers: In accordance with Section 2252.202 of the Texas Government Code steel shall be produced in the United States.
- B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- D. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- E. Deformed-Bar Anchor: ASTM A1064/ A1064M.
- F. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.04 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For slabs on void forms, provide sand plates, horizontal runners, or precast concrete blocks on bottom where base material will not support chair legs or where vapor barrier has been specified.

2.05 MECHANICAL SPLICES

- A. Provide mechanical splices designed to develop, in tension and compression, 125 percent of the minimum ASTM specified yield strength of the smaller bar being spliced. The following splicing systems are acceptable:
 - 1. Erico "Cadweld T-Series"
 - 2. Erico "Lenton"
 - 3. Dayton Barsplice "Bar-Grip"
 - 4. Dayton Barsplice "Grip-Twist"

2.06 DOWEL BAR ANCHORS

- A. Provide dowel bar anchors and threaded dowels designed to develop, in tension and compression, 125 percent of the minimum ASTM specified yield strength of the dowel bars. Unless otherwise indicated, anchors shall be furnished with ACI standard 90-degree hooks. Dowels shall be furnished by the anchor supplier. The following dowel splicing systems are acceptable:
 - 1. Richmond Screw Anchor "Dowel Bar Splicer"
 - 2. Erico "Lenton Form Saver"
 - 3. Dayton Barsplice "Grip-Twist"

2.07 EMBEDDED METAL ASSEMBLIES

- A. Steel Shapes and Plates: ASTM A36
- B. Headed Studs: Heads welded by full-fusion process, as furnished by TRW Nelson Stud Welding Division.
- C. Welded Deformed Bar Anchors: ASTM A1064/ A1064M: Welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.
- D. Reinforcing Bars to be Welded: ASTM A706.
- E. Coatings
 - 1. Epoxy coating for metal assemblies shall be "Hi-Build Epoxoline," as manufactured by the Tnemec Company, Kansas City, Missouri, applied in accordance with manufacturer's recommendations.

2.08 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F or C.
 - b. Slag Cement: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: As indicated on drawings.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 1602/C 1602M and potable.

2.09 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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 C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.010 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products:
 - a. Axim Concrete Technologies; CATEXOL Cimfilm.
 - b. BASF Construction Chemicals – Building Systems; Confilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; Vapor Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-Con.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; Pro-Film.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. BASF Construction Chemicals – Building Systems; Kure 200.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec by Dayton Superior; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Edoco by Dayton Superior; Res X Cure WB.
 - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
 - h. Kaufman Products, Inc.; Thinfilm 420.
 - i. Lambert Corporation; Aqua Kure-Clear.
 - j. L&M Construction Chemicals, Inc.; L&M Cure R.

- k. Meadows, W. R., Inc.; 1100 Clear.
 - l. Nox-Crete Products Group; Resin Cure E.
 - m. Right Pointe; Clear Water Resin.
 - n. SpecChem, LLC; Spec Rez Clear.
 - o. Symons by Dayton Superior; Resi-Chem Clear.
 - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
 - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- 1. Products:
 - a. Anti-Hydro International, Inc.; AH Clear Cure WB.
 - b. BASF Construction Chemicals – Building Systems; Kure-N-Seal WB.
 - c. ChemMasters; Safe-Cure & Seal 20.
 - d. Conspec by Dayton Superior; Cure and Seal WB.
 - e. Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.
 - f. Dayton Superior Corporation; Safe Cure and Seal (J-18).
 - g. Edoco by Dayton Superior; Spartan Cote WB II.
 - h. Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.
 - i. Kaufman Products, Inc.; Cure & Seal 309 Emulsion.
 - j. Lambert Corporation; Glazecote Sealer-20.
 - k. L&M Construction Chemicals, Inc.; Dress & Seal WB.
 - l. Meadows, W. R., Inc.; Vocomp-20.
 - m. Metalcrete Industries; Metcure.
 - n. Nox-Crete Products Group; Cure & Seal 150E.
 - o. Symons by Dayton Superior; Cure & Seal 18 Percent E.
 - p. TK Products, Division of Sierra Corporation; TK-2519 WB.
 - q. Vexcon Chemicals, Inc.; Starseal 309.
- G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- 1. Products:
 - a. BASF Construction Chemicals – Building Systems; Kure-N-Seal W.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec by Dayton Superior; High Seal.
 - d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
 - e. Edoco by Dayton Superior; Spartan Cote WB II 20 Percent.
 - f. Euclid Chemical Company (The), an RPM Company; Diamond Clear VOX; Clearseal WB STD.
 - g. Kaufman Products, Inc.; SureCure Emulsion.
 - h. Lambert Corporation; Glazecote Sealer-20.
 - i. L&M Construction Chemicals, Inc.; Dress & Seal WB.
 - j. Meadows, W. R., Inc.; Vocomp-20.
 - k. Metalcrete Industries; Metcure 0800.
 - l. Nox-Crete Products Group; Cure & Seal 200E.
 - m. Symons by Dayton Superior; Cure & Seal 18 Percent E.
 - n. Vexcon Chemicals, Inc.; Starseal 0800.
- H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- 1. Products:
 - a. BASF Construction Chemicals – Building Systems; Kure 1315.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec by Dayton Superior; Sealcure 1315 WB.
 - d. Edoco by Dayton Superior; Cureseal 1315 WB.

- e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
 - f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - g. Lambert Corporation; UV Safe Seal.
 - h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - i. Meadows, W. R., Inc.; Vocomp-30.
 - j. Metalcrete Industries; Metcure 30.
 - k. Right Pointe; Right Sheen WB30.
 - l. Symons by Dayton Superior; Cure & Seal 31 Percent E.
 - m. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.
2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)

2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Sleeves and Blockouts: Formed with galvanized metal, galvanized pipe, polyvinyl chloride pipe, fiber tubes, or wood.
- D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required; of strength and character to maintain formwork in place while placing concrete.

2.12 REPAIR MATERIALS

- A. Repair Mortar – Hand-Applied: Pre-packaged, cement-based, two-component, polymer-modified, trowel-grade mortar, enhanced with penetrating corrosion inhibitor.
 1. Compressive Strength: 1200 psi minimum at 1 day; 6000 psi minimum at 28 days when tested according to ASTM C 109.
 2. Bond Strength: 1800 psi minimum at 28 days when tested according to ASTM C 882 (Modified).
 3. Product / Manufacturer: SikaTop 122 Plus or SikaTop 123 Plus, Sika Corporation, or approved equal.
- B. Repair Mortar – Form and Pour or Pump: Pre-packaged, cement-based, single-component, polymer-modified, silica-fume-enhanced, cementitious mortar.
 1. Compressive Strength: 3000 psi minimum at 1 day; 6500 psi at 28 days when tested according to ASTM C 109.
 2. Bond Strength: 2200 psi at 28 days when tested according to ASTM C 882 (modified).
 3. Product / Manufacturer: Sika MonoTop 611, Sika Corporation, or approved equal.

2.13 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, according to ACI 301.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 2. Required average strength above specified strength:
 - a. Based on a record of past performance: Determination of required average strength above specified strength shall be based on the standard deviation record of the results of at least 30 consecutive strength tests in accordance with ACI 318, Chapter 5.3 by the larger amount defined by formulas 5-1 and 5-2.
 - b. Based on laboratory trial mixtures: Proportions shall be selected on the basis of laboratory trial batches prepared in accordance with ACI 318, Chapter 5.3.3.2 to produce an average strength greater than the specified strength f'_c by the amount defined in table 5.3.2.2.
 - 1) Proportions of ingredients for concrete mixes shall be determined by an independent testing laboratory or qualified concrete supplier.

- 2) For each proposed mixture, at least three compressive test cylinders shall be made and tested for strength at the specified age. Additional cylinders may be made for testing for information at earlier ages.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 20 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Slag Cement: 50 percent.
 4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Do not use admixtures which have not been incorporated and tested in accepted mixes.
 2. Use water-reducing admixture in concrete, as required, for placement and workability.
 3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 4. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Proportion normal-weight concrete mixture as indicated on drawings.

2.15 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 FABRICATION OF EMBEDDED METAL ASSEMBLIES

- A. Fabricate metal assemblies in the shop. Holes shall be made by drilling or punching. Holes shall not be made by or enlarged by burning. Welding shall be in accordance with AWS D1.1.
- B. Welding of deformed bar anchors and headed stud anchors shall be done by full fusion process equal to that of TRW Nelson Stud Welding Division. A minimum of two headed studs shall be tested at the start of each production period for proper quality control. The studs shall be capable of being bent 45 degrees without failure.
- C. Welding of reinforcement shall be done in accordance with AWS D1.4, using the recommended preheat temperature and electrode for the type of reinforcement being welded. Bars larger than no. 9 shall not be welded. Welding shall be subject to the observance and testing of the Testing Laboratory.
- D. Metal assemblies exposed to earth, weather or moisture shall be hot dip galvanized. All other metal assemblies shall be either hot dip galvanized or painted with an epoxy paint. Repair galvanizing after welding with a Cold Galvanizing compound installed in accordance with the manufacturer's instructions. Repair painted assemblies after welding with same type of paint.

2.17 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information.
1. When air temperature is between 85 and 95 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 95 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
 - 1. Vertical alignment:
 - a. Lines, surfaces and arises less than 100 feet in height - 1 inch.
 - b. Outside corner of exposed corner columns and control joints in concrete exposed to view less than 100 feet in height - 1/2 inch.
 - 2. Lateral alignment:
 - a. Members - 1 inch.
 - b. Centerline of openings 12 inches or smaller and edge location of larger openings in slabs - 1/2 inch.
 - c. Sawcuts, joints, and weakened plane embedments in slabs - 3/4 inch.
 - 3. Level alignment:
 - a. Elevation of slabs-on-grade - 3/4 inch.
 - b. Elevation of top surfaces of formed slabs before removal of shores - 3/4 inch.
 - c. Elevation of formed surfaces before removal of shores - 3/4 inch.
 - d. Lintels, sills, parapets, horizontal grooves, and other lines exposed to view - 1/2 inch.
 - 4. Cross-sectional dimensions: Overall dimensions of beams, joists, and columns and thickness of walls and slabs.
 - a. 12 inch dimension or less - plus 3/8 inch to minus 1/4 inch.
 - b. Greater than 12 inch to 3 foot dimension - plus 1/2 inch to minus 3/8 inch.
 - c. Greater than 3 foot dimension - plus 1 inch to minus 3/4 inch.
 - 5. Relative alignment:
 - a. Stairs:
 - 1) Difference in height between adjacent risers - 1/8 inch.
 - 2) Difference in width between adjacent treads - 1/4 inch.
 - 3) Maximum difference in height between risers in a flight of stairs - 3/8 inch.
 - 4) Maximum difference in width between treads in a flight of stairs - 3/8 inch.
 - b. Grooves:
 - 1) Specified width 2 inches or less - 1/8 inch.
 - 2) Specified width between 2 inches and 12 inches - 1/4 inch.
 - c. Vertical alignment of outside corner of exposed corner columns and control joint grooves in concrete exposed to view - 1/4 inch in 10 feet.
 - d. All other conditions - 3/8 inch in 10 feet.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class D, 1 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide elevation or camber in formwork as required for anticipated formwork deflections due to weight and pressures of concrete and construction loads.

- H. Foundation Elements: The sides of all below grade portions of beams, pier caps, walls, and columns shall be formed straight and to the lines and grades specified. Foundation elements shall not be earth formed unless specifically indicated on the Drawings.
- I. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- J. Chamfer exterior corners and edges of permanently exposed concrete.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- L. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- M. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- N. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.
 - 1. Do not apply form release agent where concrete surfaces are scheduled to receive subsequent finishes which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Spacing within a bolt group: 1/8"
 - b. Location of bolt group (center): 1/2"
 - c. Rotation of bolt group: 5 degrees
 - d. Angle off vertical: 5 degrees
 - e. Bolt projection: $\pm 3/8$ "
 - 2. Headed Studs: Heads welded by full-fusion process, as furnished by TRW Nelson Stud Welding Division.
 - 3. Welded Deformed Bar Anchors: ASTM A1064/ A1064M: Welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.

3.03 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Formwork supporting conventionally reinforced concrete shall not be removed until concrete has attained 85 percent of its specified 28-day compressive strength as established by tests of field cured cylinders. In the absence of cylinder tests, supporting formwork shall remain in place until the concrete has cured at a temperature of at least 50 degrees Fahrenheit (10 degrees Celsius) for the minimum cumulative time periods given in ACI 347, Section 3.7.2.3. When the surrounding air temperature is below 50 degrees Fahrenheit (10 degrees Celsius), that time period shall be added to the minimum listed time period.
 - 2. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems which allow form removal without disturbing shores, but only after the Contractor has demonstrated to the satisfaction of the Architect that the early removal of forms will not cause excessive sag, distortion or damage to the concrete elements.

3. Wood forms shall be completely removed. Provide temporary openings if required.
 4. Provide adequate methods of curing and thermal protection of exposed concrete if forms are removed prior to completion of specified curing time.
 5. Obtaining concrete compressive strength tests for the purposes of form removal shall be the responsibility of the Contractor.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
1. Weld reinforcing bars according to AWS D1.4, where indicated. Only steel conforming to ASTM A706 may be welded.
- D. Installation tolerances:
1. Top and bottom bars in structured slabs, girders, beams and joists:
 - a. Members 8" deep or less: $\pm 3/8$ "
 - b. Members more than 8" deep: $\pm 1/2$ "
 2. Concrete Cover to Formed or Finished Surfaces: $\pm 3/8$ " for members 8" deep or less; $\pm 1/2$ " for members over 8" deep, except that tolerance for cover shall not exceed 1/3 of the specified cover.
- E. Concrete Cover: Refer to the Structural Notes.
- F. Splices: Provide standard reinforcement splices by lapping and tying ends. Comply with ACI 318 for minimum lap of spliced bars where not specified on the documents.
- G. Mechanical Splices: Use for splicing of bars larger than no. 11 or where no. 11 bars are spliced to larger size bars and where indicated on the drawings. Comply with manufacturer's instructions for preparation of bars and installation procedures.
- H. Field Welding of Embedded Metal Assemblies: All paint and galvanizing shall be removed in areas to receive field welds. All areas where paint or galvanizing has been removed shall be field repaired with the specified paint or cold galvanizing compound, respectively.
- I. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- J. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.05 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs unless otherwise indicated.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, and only if specifically noted as withheld on the batch ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
 2. Water content shall not exceed the maximum specified water/cement ratio for the mix.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
 4. Do not permit concrete to drop freely any distance greater than 20'-0" for concrete containing a high range water reducing admixture (superplasticizer) or 5'-0" for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.
 5. Pump priming grout shall be discarded and not used in the structure.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 305.1 and as follows:
1. Maintain concrete temperature below 95 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
1. Housekeeping pads: Concrete fill shall be normal weight concrete (3000 psi), reinforced with 4x4-W2.1xW2.1 welded wire mesh set at middepth of pad. Trowel concrete to a dense, smooth finish. Set anchor bolts for securing mechanical or electrical equipment during pouring of concrete fill.
- D. Protective slabs ("Mud slabs"): Concrete fill shall be normal weight concrete (2500 psi minimum) with a minimum thickness of 3 1/2". Reinforce protective slabs with 6x6-W2.9xW2.9 welded wire mesh reinforcing. Finish slab to a wood float finish.

3.9 INSTALLATION OF NON-SHRINK GROUT UNDER BASEPLATES

- A. Grout under all bearing and baseplates. Comply with manufacturer's instructions. Do not dry pack.

- B. Mixing: Use a mechanical mixer. Add only enough water to make grout placeable. Do not mix more grout than can be used in 20 minutes. Under no circumstances shall grout be retempered.

3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 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 before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.11 CONCRETE SURFACE REPAIRS

- A. Surface Defects in Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Owner's approval.
- B. Contractor shall submit a detailed, descriptive procedure listing proposed pre-packaged repair materials and methods for the repair of surface defects prior to the start of repair work.

- C. Patching Mortar: Mix, place and finish pre-packaged repair mortar in accordance with manufacturer's instructions.
- D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, minor honeycombs and rock pockets with no exposed reinforcement, 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 minor honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface, 1/4 inch deep minimum. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view using pre-packaged repair mortar so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
- E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include minor spalls, pop outs, honeycombs and rock pockets with no exposed reinforcement, crazing and cracks in excess of 0.01 inch wide that do not penetrate to reinforcement, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with patching mortar. Remove defective areas with clean, square cuts, 1/4" deep minimum. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Place, compact, and finish patching mortar to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
 - 8. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.12 STRUCTURAL REPAIRS

- A. Structurally Defective Concrete: Structural defects include spalls, honeycombs or rock pockets with exposed reinforcement, hollow-sounding concrete, cracks that penetrate to the reinforcement or completely through concrete elements, inadequate cover over reinforcement, and other conditions that affect the structural performance or durability of the concrete as determined by the Engineer.

- B. Repair structural defects in concrete in accordance with plans, specifications, details, etc. provided by the Engineer.
 - 1. The cost of the additional services provided by the Engineer to prepare the repair documents, and to oversee the repair work shall be borne by the Contractor.
- C. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.13 CLEANUP

- A. Imperfect or damaged work or any material damaged or determined to be defective before final completion and acceptance of the entire job shall be satisfactorily replaced at the Contractor's expense, and in conformity with all of the requirements of the Drawings and Specifications. Removal and replacement of concrete work shall be done in such manner as not to impair the appearance or strength of the structure in any way.
- B. Cleaning: Upon completion of the work all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the site. After sweeping floors, wash floors with clean water. Finished concrete surfaces shall be left in a clean condition, satisfactory to the Owner.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner may engage a special inspector and/or a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections may include:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure four cylinders for each composite sample.
 - 1) Do not transport field-cast cylinders until they have cured for a minimum of 24 hours.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M;
 - a. Test one cylinder at 7 days
 - b. Test two cylinders at 28 days
 - c. Test one cylinder at 56 days

- d. If 4" by 8" cylinders are used, provide 1 additional cylinder at each stage
7. 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.
8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. 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.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 - a. When the strength level of the concrete for any portion of the structure, as indicated by cylinder tests, falls below the specified requirements, the Contractor shall provide improved curing conditions and/or adjustments to the mix design as required to obtain the required strength. If the average strength of the laboratory control cylinders falls so low as to be deemed unacceptable, the Contractor shall follow the core test procedure set forth in ACI 301, Section 1.6. Locations of core tests shall be approved by the Architect. Core sampling and testing shall be at Contractors expense.
 - b. If the results of the core tests indicate that the strength of the structure is inadequate, any replacement, load testing, or strengthening as may be ordered by the Architect shall be provided by the Contractor without cost to the Owner.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION

**SECTION 03 3500
CONCRETE FLOOR FINISHING**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2024.
- B. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.
- C. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.
- D. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 SUMMARY

- A. This Section includes the following:
 - 1. Finishing slabs-on-grade, monolithic floor slabs, and separate floor toppings.
 - 2. Surface treatment with concrete sealer.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete slab construction and finish.
 - 2. Division 7 Section "Joint Sealants"
 - 3. Division 9 Section "Floor Sealer" for floor sealer.

1.04 REFERENCES

- A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 302 - Guide for Concrete Floor and Slab Construction
 - 3. ASTM E1155 - Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E 548.
- B. Submittals
 - 1. Product Data: Submit manufacturer's data showing compliance with the specifications for the following products:
 - a. Sealer
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
 - 1. The Contractor shall call a meeting to review the detailed requirements for floor construction, including the concrete placing techniques, finishing techniques, curing techniques, and the application of floor finishing materials. All contractors involved in the floor installation shall attend the conference.
 - 2. The Contractor shall notify the Owner, Architect and the Structural Engineer at least 10 business days prior to the scheduled date of the conference.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2.02 FLOOR AND SLAB TREATMENTS

- A. Penetrating sealer:
 - 1. See Section"

2.03 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Sawcut joint filler: Euco 700 epoxy by The Euclid Chemical Company, or approved equal.

PART 3 EXECUTION

3.01 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Concrete slabs shall be finished as specified below, within the tolerances specified elsewhere in this Section.
 - 1. Highway straightedges are recommended for use in lieu of bullfloats for all slab placement and finishing operations.
 - 2. Screeding: Immediately after placing, slab shall be vibrated and struck off true by double screeding to the required level, at or below the elevation or grade of the finished slabs as indicated on the Drawings. Vibrators shall not be used to spread the concrete. When camber is indicated for slabs supported on formwork, screed to the required camber. Fixed screed guides are recommended where specified surface tolerance exceeds FF25/FL20.
 - 3. Floating: Immediately after screeding, before any excess bleed water is present on the surface, float the surface using long-handled bull floats or darbies.
 - 4. Straightedging: Immediately after screeding and before excess bleed water is present on the surface, straighten the surface using a highway straightedge.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
 - 2. Locations: All concrete surfaces under waterproofing membrane, setting beds for brick, mud-set tile, pavers, or terrazzo, and noncomposite topping slabs.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. 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.

2. Locations: Exposed concrete floors not otherwise specified, concrete surfaces under carpets, vinyl tile, thin set tile, wood flooring, elastomeric coatings, and painted concrete floors, and roof slabs that are future floors.
- E. 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 thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.02 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than seven days' old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.03 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.04 CONCRETE FINISH MEASUREMENT AND TOLERANCES

- A. All floors are subject to measurement for flatness and levelness and shall comply with the following:
 1. Measurement Standard: All floors are subject to measurement for flatness and levelness, according to ASTM E1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System."
- B. Two Tiered Measurement Standard: Each floor test section and the overall floor area shall conform to the two-tiered measurement standard as specified herein.
 1. Minimum Local Value: The minimum local FF/FL values represent the absolute minimum surface profile that will be acceptable for any one test sample (line of measurements) anywhere within the test area.
 2. Specified Overall Value: The specified overall FF/FL values represent the minimum values acceptable for individual floor sections as well as the floor as a whole.
- C. Floor Test Sections
 1. A floor test section is defined as the smaller of the following areas:
 - a. The area bounded by column and/or wall lines.
 - b. The area bounded by construction and/or control joint lines.
 - c. Any combination of column lines and/or control joint lines.
 2. Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines, as defined by ASTM E1155, at a spacing to be determined by the Owner's testing agency.

3. The precise layout of each test section shall be determined by the Owner's testing agency.
- D. Concrete Floor Finish Tolerance
 1. The following values apply before removal of shores. Levelness values (FL) do not apply to intentionally sloped or cambered areas, nor to slabs poured on metal deck or precast concrete.
 - a. Suspended/Structured Slabs:
 - 1) Floors to be covered with carpet or vinyl tile, unless otherwise specified:
 - (a) Overall Value FF25/FL20
 - (b) Minimum Local Value FF17/FL15
 - 2) Floors to be covered with thin-set tile:
 - (a) Overall Value FF35/FL20
 - (b) Minimum Local Value FF24/FL15
 - 3) Mechanical rooms, thickset tile, recessed floors and roof slabs:
 - (a) Overall Value FF20/FL15
 - (b) Minimum Local Value FF15/FL10
- E. Floor Elevation Tolerance Envelope:
 1. The acceptable tolerance envelope for absolute elevation of any point on the slab surface, with respect to the elevation shown on the Drawings, is as follows:
 - a. Slab-on-Grade Construction: +/- 3/4"- Typ. U.N.O.
 - b. Top surfaces of formed slabs measured prior to removal of supporting shores: +/- 3/4"
 - c. Top surfaces of all other slabs: +/- 3/4"
 - d. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10'-0" at any point, up to 3/4" from theoretical elevation at any point.

3.05 FIELD QUALITY CONTROL

- A. Concrete Floor Flatness and Levelness:
 1. Measurement Standard: Floors shall be measured for flatness and levelness according to ASTM E1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System." Tolerances are specified in Section 033000.
 2. Time Period for Measuring and Reporting: All measurements shall be made by the testing laboratory or designated agency before the end of the next workday after the completion of finishing operations. For structural elevated floors, measurement shall also be made prior to removal of forms and shores. The Contractor shall be notified immediately after the measurements of any section are complete, and a written report of the floor measurement results shall be submitted within 72 hours after finishing operations are complete. The Contractor shall take immediate action to correct any work that is outside the specified tolerances.
 3. Measuring Equipment: The concrete surface profile shall be measured using equipment manufactured for the purpose, such as the Dipstick Floor Profiler, as manufactured by the Edward W. Face Company, Norfolk, Virginia, or by other methods specified in ASTM E1155.
 4. Floor Test Sections:
 - a. A floor test section is defined as the smaller of the following areas:
 - 1) The area bounded by column and/or wall lines.
 - 2) The area bounded by construction and/or control joint lines.
 - 3) Any combination of column lines and/or control joint lines.
 - b. Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines.
 - c. The precise layout of each test section shall be determined by the testing agency and shall be submitted for the Architect's review and approval.

3.06 REPAIRS

- A. Remedial Measures for Slab Finish Construction not Meeting Specified Tolerances:

1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:
 - a. The composite overall values of flatness or levelness of any test section or the entire floor installation measure less than specified values.
 - b. Any individual test sample (line of measurements) measures less than the specified absolute minimum flatness or levelness value.
2. Modification of Existing Surface:
 - a. If, in the opinion of the Architect or Owner's representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall immediately undertake the approved repair method.
 - b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair, and time required to make the repair.
 - c. Repair method(s), at the sole discretion of the Architect or Owner's Representative, may include grinding (floor stoning), planing, retopping with specified floor leveling compound, or any combination of the above.
 - d. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.
3. Removal and Replacement:
 - a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall remove and replace the defective work as directed.
 - b. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
 - c. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

END OF SECTION

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SECTION 05 1200
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel framing members and connections.
 - 2. Deck support angles.
 - 3. Slide bearings.
 - 4. Shop prime painting and touch up painting in the field.
 - 5. Temporary construction bracing.
 - 6. Fabrication and erection inspection and testing.
- B. Related Sections include the following:
 - 1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Division 1 Section "Submittals" for administrative requirements for the submission of shop drawings and other submittals.
 - 3. Division 5 Section "Steel Deck" for field installation of shear connectors.
 - 4. Division 5 Section "Prefabricated Modular Stair Systems".

1.03 DEFINITIONS

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

1.04 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand LRFD factored loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using schematic details indicated and AISC's "Steel Construction Manual, edition as referenced in the Building Code.
 - 2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.
- B. Construction: Type PR, partially restrained.

1.05 SUBMITTALS

- A. Submit in accordance with Division 1 Section "Submittals".
- B. Submittals for Review
 - 1. Provide complete details and schedules for fabrication and shop assembly of members, erection plans, details, procedures, and diagrams showing sequence of erection of structural steel components.
 - a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - b. Include embedment drawings.
 - c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.
 - 2. Shop drawings and erection drawings shall not be made by using reproductions of Contract Drawings.
 - 3. Structural steel members for which shop drawings have not been reviewed shall not be fabricated. Engineer's review shall cover general locations, spacings, and details of design. Omission from shop drawings of any materials required by the Contract Documents shall

not relieve the Contractor of the responsibility of furnishing and installing such materials, even though such shop drawings may have been reviewed and returned.

C. Submittals for Information:

1. Product Data: For each type of product indicated.
2. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Connection Calculations: Contractor shall design all connections not specifically detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas. Submit design calculations for the connections designed by the contractor, prior to or with the steel shop drawings. Shop drawings containing connections for which calculations have not been received shall be returned unchecked as an incomplete submittal. Calculations shall be retained for the Engineer's file and will not be approved or returned.
 - a. Connections shall be designed in accordance with the requirements specified in the Structural Drawings and Specifications.
 - b. Beam connections: Submit a complete calculation for each different beam connection used and detailed on the shop drawings. Conditions which are similar may be grouped together so as to utilize a single connection design.
 - c. Submit complete connection calculations for wind brace connections, truss connections, moment connections and other connections where specified on the Contract Drawings. Each calculation shall identify the location or locations for which the connection applies, the member mark(s) from the Contract Documents, the piece mark(s) from the shop drawings, the member size, the design loading(s), member size, and the end of the member to which the connection applies.
 - d. The unit of measurement for the connection calculations must follow the United States customary system (USCS).
4. Welding certificates.
5. Qualification Data: For Installer, fabricator, and testing agency.
6. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - a. Structural steel including chemical and physical properties.
 - b. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - c. Shear stud connectors.
 - d. Shop primers.
 - e. Nonshrink grout.
7. Source quality-control test reports.

1.06 QUALITY ASSURANCE

- A. **Installer Qualifications:** Company specializing in performing the work of this section with minimum 5 years documented experience.
- B. **Fabricator Qualifications:** Company specializing in performing the work of this section with minimum 10 years of documented experience.
- C. **Welding:** Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- D. The latest adopted edition of all standards referenced in this Section shall apply unless noted otherwise. In case of conflict between these Contract Documents and the referenced standard, the Contract Documents shall govern. In case of conflict between these Contract Documents and the Building Code, the more stringent shall govern.
- E. The Contractor shall furnish fabrication and erection inspection and testing of all welds in accordance with AWS D1.1, Chapter 6. Submit records of inspections and tests to the Owner's testing laboratory for their review. The fabrication and erection inspectors shall be AWS certified welding inspectors.

- F. All materials, fabrication procedures and field erection are subject to verification inspection and testing by the Owner's testing laboratory in both the shop and field. Such inspections and tests will not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with specified requirements.
- G. Qualifications for Welding Work: Contractor shall be responsible for qualifying welding operators in accordance with the AWS "Standard Qualification Procedure." Provide certification to Owner's testing laboratory that welders to be employed in the work have satisfactorily passed AWS qualification tests. Recertification of welders shall be Contractor's responsibility.
- H. Qualification of Welding Procedures: Contractor shall provide the testing laboratory with welding procedures which are to be used. Welding procedures shall be qualified prior to use in accordance with AWS D1.1, Part B.
- I. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges"
 - 2. AISC's "Specification for Structural Steel Buildings."
 - 3. ASTM A6 "Specifications for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
 - 5. RCSC's "Specification for Structural Joints Using High Strength Bolts."
 - 6. AWS D1.1 "Structural Welding Code"
 - 7. SSPC (Society for Protective Coatings), standards as noted.
- J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 COORDINATION

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

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. Source of Steel Producers: In accordance with Section 2252.202 of the Texas Government Code steel shall be produced in the United States.
- B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- C. W-Shapes: ASTM A 992.
- D. Channels, Angles: ASTM A 36.
- E. Plate and Bar: ASTM A 36.
- F. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.
- G. Steel Pipe: ASTM A 53, Type E or S, Grade B.
 - 1. Weight Class: As indicated.
 - 2. Finish: Black, except where indicated to be galvanized.

- H. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125, grade A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
1. Finish: Plain.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- D. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
1. Configuration: Straight.
 2. Nuts: ASTM A 563 hex carbon steel.
 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 4. Washers: ASTM F 436 hardened carbon steel.
 5. Finish: Plain.
- E. Threaded Rods: ASTM A 193.
1. Nuts: ASTM A 563 hex carbon steel.
 2. Washers: ASTM A 36 carbon steel.
 3. Finish: Plain.

2.03 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- B. Galvanizing Repair Paint: ASTM A 780.
- C. Cold Galvanizing Compound shall be "ZRC" cold galvanizing compound as manufactured by ZRC Worldwide, Marshfield, Massachusetts.

2.04 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, Grade B, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time, capable of developing a minimum compressive strength of 5,000 psi at 28 days.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges", AISC's "Specification for Structural Steel Buildings", and as indicated on accepted shop drawings.
1. Camber structural-steel members where indicated.
 2. Mill tolerances shall conform to ASTM A6. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 3. Mark and match-mark materials for field assembly.
 4. Plates shall be free of gross discontinuities such as ruptures and delaminations. Plates shall comply with ASTM A578, Level 1.
 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.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads. Members in compression joints which depend on contact bearing shall have the bearing surfaces milled to a common plane. Members to be milled shall be completely assembled before milling.
- E. Base Plates: Oversize anchor bolt holes in base plates to facilitate erection as specified in Table 14-2 in AISC 360-10.
- F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning, SSPC-SP 2, "Hand Tool Cleaning, or SSPC-SP 3, "Power Tool Cleaning."
- G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
 - 2. Provide washers over all slotted holes in an outer ply.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.

2.07 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Galvanized surfaces.
 - 5. Top surfaces of beams which support composite metal floor deck.
 - 6. Headed shear studs, although overspray is acceptable.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 - 1. Fill vent holes and grind smooth after galvanizing.

- B. Galvanizing: The following steel shall be hot-dip galvanized (including any associated fasteners):
 - 1. Lintels and shelf angles attached to structural-steel frame and located in exterior walls.
 - 2. Railing exposed to weather.

2.09 SLIDE BEARINGS

- A. Reinforced teflon, factory prebonded to steel plates with initial static coefficient of friction not to exceed 0.06, over a working stress range of 500 to 2000 psi. Bearing shall be one of the following:
 - 1. "Fluorogold" slide bearings, Seismic Energy Products, L.P., Athens, Texas
 - 2. "Con-Slide" slide bearings, Con-Serv, Inc., East Hampton, New Jersey

2.010 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 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. Design of temporary bracing and supports shall be the responsibility of the Contractor. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design," unless closer tolerances are required for proper fitting of adjoining or enclosing materials, in which case the more stringent shall apply.

- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
 - 5. Grout under baseplates in accordance with Section 033000.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges," Unless adjoining materials dictate a tighter tolerance.
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated. Any member having a splice not shown and detailed on the accepted shop drawings shall be rejected.
- F. Do not field cut or alter structural members without approval of Architect/Engineer. Do not use thermal cutting during erection unless approved by Architect/Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.
- G. Gas Cutting: Do not use gas cutting torches in the field to correct fabrication errors in structural framing.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
 - 2. A307 bolts and high-strength (ASTM F3125, grade A325 and grade A490) bolts noted to be "snug-tight" shall be tightened using a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench, bringing the plies into contact.
 - 3. High-strength bolts which are not specifically designated to be "snug-tight" shall be tightened to provide at least the minimum tension shown in Table 4 of the "Specification for Structural Joints using ASTM F3125, grade A325 and grade A490 Bolts." Tightening shall be done by the turn-of-the-nut method, with direct tension indicators, or by properly calibrated wrenches.
 - 4. Bolts tightened with a calibrated wrench or by torque control shall have a hardened washer under the element (nut or bolt head) turned in tightening.

5. Hardened washers shall be placed over slotted holes in an outer ply. Hardened beveled washers shall be used where the outer face of the bolted parts has a slope greater than 1:20 with respect to the bolt axis.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.
 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touch-up Cold Galvanizing: Touch up areas of hot dip galvanized members where galvanizing has been abraded during shipping and erection and areas where galvanizing has been removed or damaged due to welding. Apply cold galvanizing compound in accordance with the manufacturer's instructions to a minimum dry film thickness of 2.0 mils.

END OF SECTION

SECTION 05 3100
STEEL DECK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Composite floor deck.
- B. Work Included
 - 1. Furnish all labor and materials required to fabricate, deliver and install steel roof deck and accessories including formed steel cant strips, eave strips, valley strips, sump pans, edge closures, pour stops, reinforcing plates and related accessories.
 - 2. Furnish all labor and materials required to fabricate, deliver and install steel floor deck and accessories including formed steel end closures, edge forms, flashings, and reinforcing plates, headed shear studs, and related accessories.
- C. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for structural concrete fill over steel deck.
 - 2. Division 5 Section "Structural Steel" for shop- and field-welded shear connectors.

1.03 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
 - 2. Product Data: For each type of deck, accessory, and product indicated. Provide deck dimensions, sectional properties, uplift resistance and diaphragm capacity for specified fastener layout and support spacing, and finishes.
- B. Submittals for Information:
 - 1. Product Certificates: For each type of steel deck, signed by product manufacturer. Certify that products comply with SDI, UL and ICC standards as specified.
 - 2. Manufacturer's installation instructions.
 - 3. Welding certificates: For each welder employed on the Work.
 - 4. Field quality-control test and inspection reports.
 - 5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - a. Power-actuated mechanical fasteners.
 - 6. ICC Evaluation Service Reports: Deck units shall be approved by the International Code Council and shall have a corresponding report from ICC.
 - 7. Deck units shall be classified by Underwriter's Laboratory, Inc. and shall be labeled and marked as required by UL, indicating manufacturer testing and inspection.

1.04 QUALITY ASSURANCE

- A. Installer: Company specializing in performing the work of this Section with minimum 5 years documented experience.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
 - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- E. Comply with applicable provisions of the following specifications and documents.
 - 1. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
 - 2. SDI (Steel Deck Institute) - Design Manual for Composite Decks, Form Decks, Roof Decks.
 - 3. UL - Fire Resistance Directory.
- F. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source of Steel Producers: In accordance with Section 2252.202 of the Texas Government Code steel shall be produced in the United States.
- B. 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:
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Deck:
 - a. Canam Steel Corp.;The Canam Manac Group.
 - b. Consolidated Systems, Inc.
 - c. Epic Metals Corporation.
 - d. New Millennium Building Systems, LLC.
 - e. Nucor Corp.; Vulcraft Division.
 - f. Verco Manufacturing Co.

2.02 COMPOSITE FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A 653/A, Structural Steel (SS), Grade as indicated, G30 zinc coating.
 - 2. Profile Depth: As indicated.
 - 3. Design Uncoated-Steel Thickness: As indicated.
 - 4. Span Condition: As indicated.

2.03 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
 - 1. Mechanical Fasteners: Galvanized hardened steel, self-tapping "Teks" screws, manufactured by Illinois Tool Works, Inc., Buildex Division, or equal. Size shall be #10 minimum, unless noted otherwise.
 - 2. Powder Actuated Fasteners: Zinc coated fastener with .145 inch shank diameter and 1 1/4 inch shank length. X-ENP-19 pin as manufacturer by Hilti, or equal.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, sealed watertight. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: ASTM A780.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.03 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: As indicated.
 - 2. Weld Spacing: As indicated.

3. Welds may be omitted if stud shear connectors are provided at same or closer spacing.
- B. Fasten deck to concrete support members at ends and intermediate supports with powder actuated fasteners at 12 inches maximum spacing if deck spans parallel to the supporting member and at every other flute if the deck spans perpendicular to the supporting member.
- C. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 2. Mechanically clinch or button punch.
 3. Fasten with a minimum of 1-1/2-inch- long welds.
- D. End Bearing: Install deck ends over supporting steel frame with a minimum end bearing of 1-1/2 inches. Install deck on masonry and concrete support surfaces with 3 inch minimum bearing. Provide end joints as follows:
 1. End Joints: Lapped.
- E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
 1. Install wet concrete stops at floor edges and around openings and penetrations upturned to top surface of slab, to contain wet concrete. If size of stop is not shown on the Drawings, provide stops of sufficient strength to deflect no more than 1/8 inch vertically or horizontally.
- F. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Fusion weld or mechanically fasten plate to deck at 12 inches maximum spacing.
- G. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- H. Position floor drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

**SECTION 05 5100
PREFABRICATED MODULAR STAIR SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Prefabricated stairs.
- B. Structural steel stair framing and supports.
- C. Handrails and guards.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Placement of metal anchors in concrete.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/NFSI B101.3 - Test Method for Measuring the Wet DCOF of Hard Surface Walkways; 2020.
- C. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2023.
- D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Prefabricated Metal Stairs:
 - 1. Upside Innovations, a SixAxis company: www.upsideinnovations.com

2.02 METAL STAIRS - GENERAL REQUIREMENTS

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 - 2. Handrails: Comply with applicable accessibility requirements of ADA Standards and Texas Accessibility.
 - 3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
 - a. Stair Capacity: Uniform live load of 100 lb/sq ft and a concentrated load of 300 lb with deflection of stringer or landing framing not to exceed 1/360 of span.
 - b. Railing Assemblies: Comply with applicable local code.
 - 4. Aluminum welding will be in accordance with ANSI / AWS D1.2/D1.2M: 2008. Welding shall be performed solely with Pulsed Gas Metal Arc Welding (MIG) processes or Gas Tungsten Arc Welding (TIG) processes by experience operators.
 - 5. Dimensions: As indicated on drawings.
 - 6. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 7. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 8. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.

- d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.03 PLATFORMS & LANDINGS

- A. Walking surfaces are designed to carry a uniform live load of 100 pounds per square foot and a concentrated vertical load of 300 pounds in an area of one square foot.
- B. Platform sections are fabricated in typical lengths between 48" and 96" in each 8" increment. Custom lengths can be fabricated as requested.
- C. Walking surfaces are designed to have a coefficient of friction no less than 0.50 in all directions of travel.
- D. Walking surfaces are designed and constructed to be continuous, without gaps and shall be made using 1-1/2" x 8" extruded decking. The outside legs of each piece of extrusion should be touching the adjacent piece in order to create a hard stop for structural support.
- E. All platforms are designed to be wider than the step leading up to them and at least 60" long in the
- F. All platforms are designed to allow at least a 60" diameter area of clearance free of obstructions.
- G. Platforms shall be fabricated in typical 5'-4" x 5'-4" sections. Larger sizes will be fabricated as required by layout.
- H. Platforms shall be designed as a universal design, so that a common platform can be configured as a resting platform, switchback platform, turning platform, walkway platform, or threshold landing platform.

2.04 PLATFORM LEGS

- A. All legs are designed to support the steps and platforms / landings.
- B. Platform legs shall be designed using a minimum of 3" x 3" x 0.125" aluminum square tube that connects to the platform and a telescoping 2.7" x 2.7" x 0.125" aluminum square tube with a 6" x 6" x .190" welded foot pad. The legs are bolted wall to wall with two 18-8 stainless steel bolts. The telescoping feature allows leg adjustment in order to meet elevation changes.
- C. Depending on total height of platforms, legs can increase in size based on structural design.
- D. When needed, 2" x 2" x 3/16" aluminum angle is used for cross-bracing platform legs. As heights are increased cross-bracing sizing will be increased in order to provide structural integrity.

2.05 STEPS

- A. Step treads and stringers are designed to carry a uniform live load of 100 pounds per square foot
- B. Walking surfaces are designed to have a coefficient of friction no less than 0.50 in the normal direction of travel.
- C. Steps are designed to allow a clearance of 48" between handrails.
- D. All step treads are designed to have a uniform depth of 12" with a 1" nosing for an effective run of 11" minimum per step, INCLUDING THE TOP STEP ONTO THE PLATFORM / LANDING.
- E. All step nosings have a uniform radius of 1/4" and an underside angle of 60 degrees from the horizontal.
- F. Step treads are designed to have a uniform height of either 6", 6-1/2", or 7" depending on the overall height of the step assembly. All step risers are closed between treads.

- G. Step treads are designed to allow a clearance of 48" between handrails.

2.06 STEP RAILS

- A. All step rails are designed to withstand a concentrated load of 200 pounds applied in any direction on the top of the rail.
- B. Steps over 30": Step rails for steps with a vertical rise over 30" shall have a 42" guardrail in addition to the 36" handrail.
- C. Steps 30" or under: Step rails for steps at 30" or under do not require a 42" guardrail.
- D. All baluster panels and other custom rail panels are designed to withstand a load of 50 pounds in the horizontal direction applied in an area of one square foot.
- E. All step rails will not allow a 4" diameter sphere to pass through in any area.
- F. Step rails are provided on both sides of the step treads.
- G. All step handrails are designed to be continuous along step runs and in between the inside corner of 90 degree and 180 degree turns in step direction. Handrails are not interrupted by posts or other obstructions.
- H. All handrails have a clearance of 2-1/4" between the handrail and the guardrail. Handrails are to be constructed of 1-1/4" SCH 40 Pipe with an outside diameter of 1.66".
- I. Step handrails are designed to be 36" high measured vertically from the top of the step nosing to the top of the rail.
- J. Step handrails extend 12" past the top Step Nosing parallel to the ground surface and return to the
- K. closest rail post or wall if needed due to door swing interference at the top of the step. Step
- L. Upside Innovations, LLC
- M. 5470 Spellmire Dr.
- N. West Chester, OH 45246
- O. p: 513.889.2492 f: 513.672.2124
- P. handrails also extend one tread width past the bottom step tread (11") plus an additional 12"
- Q. parallel to the ground surface and return to the closest rail post.
- R.

2.07 HANDRAILS AND GUARDS

END OF SECTION

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**SECTION 06 1053
MISCELLANEOUS ROUGH CARPENTRY**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Wood and plywood blocking and nailers.
 - 2. Plywood backing panels.

1.03 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NHLA: National Hardwood Lumber Association.
 - 3. NLGA: National Lumber Grades Authority.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPA: Western Wood Products Association.

1.04 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. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.05 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.

1.06 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

2.01 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. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 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.
- D. Application: Treat
 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than 18 inches above the ground in crawl spaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.03 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 1. Mixed southern pine, No. 2 grade; SPIB.
 2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
 3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 4. Eastern softwoods, No. 2 Common grade; NELMA.
 5. Northern species, No. 2 Common grade; NLGA.
 6. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.
- 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.

2.04 PLYWOOD FOR BLOCKING AND NAILERS

- A. Plywood: DOC PS 1, Exterior, AC, in thickness indicated.
- B. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- C. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

- D. Application: Treat all plywood used for blocking and nailers.

2.05 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exterior, AC, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.06 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. Power-Driven Fasteners: NES NER-272.
- D. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- 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 o.c.
- F. Sort and select lumber so that natural characteristics will 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.
- G. Comply with AWPA 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.

- H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- I. 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.

3.02 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

SECTION 07 8413 PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 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 07 8443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.02 ALLOWANCES

- A. Penetration firestopping Work is part of an allowance.

1.03 UNIT PRICES

- A. Work of this Section is affected by unit prices.

1.04 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. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.06 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.08 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.

1.09 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

2.01 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.02 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 firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) FM Approvals in its "Approval Guide."

2.03 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 are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [3M Building and Construction](#).
 - b. [Hilti, Inc.](#)
 - c. [Passive Fire Protection Partners](#).
 - d. [Specified Technologies Inc.](#)
 - e. [Tremco Incorporated](#).
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
 - 3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. 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 E84.
- 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.

2.04 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 strips for use around combustible penetrants.
- 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: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. 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.
- K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.
- L. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.
- M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.
- N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.
- O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.
- P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.

- Q. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.
- R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch diameter.
- S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.
- T. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.05 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

3.01 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.

3.02 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.

3.03 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- 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.

3.04 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 high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- 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 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.

3.05 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 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.

END OF SECTION

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SECTION 07 8443 JOINT FIRESTOPPING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- B. ASTM D6904 - Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied on Masonry; 2003 (Reapproved 2022).
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- D. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- E. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).
- F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2023b.
- G. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2020a.
- H. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated construction.
 - 2. Joints at exterior curtain-wall/floor intersections.
 - 3. Joints in smoke barriers.
- B. Related Requirements:
 - 1. Section 07 8413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Joints in or between fire-resistance-rated construction.
 - 2. Joints at exterior curtain-wall/floor intersections.
 - 3. Joints in smoke barriers.
- 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 developed in accordance with current International Firestop Council (IFC) guidelines.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.06 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.08 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.

1.09 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

2.01 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.02 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 firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
- B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.03 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 must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
 - 1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
 - 2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
 - 3. Provide firestop products that do not contain ethylene glycol.
- B. Intumescent Gypsum Wall Framing Gaskets (Applied to Steel Tracks, Runners, and Studs prior to Framing Installation): Provide products with fire, smoke, and acoustical ratings that allow

movement up to 100 percent compression and/or extension in accordance with UL 2079 or ASTM E1966; have an L Rating less than 1 cfm/ft. in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 inch accordance with ASTM E90 or ASTM C919.

- C. For aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least 2-1/2 by 5 inches, provide perimeter fire-barrier system that does not require direct screw attachment to mullions and transoms to support and fasten curtain-wall insulation. System to be tested in accordance with ASTM E2307 for up to 2-hour fire resistance and with ASTM E1233 for wind cycling equivalent to 108 mph wind for 500 cycles.
- D. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 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.
- E. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.
 - 1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- F. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- G. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.04 ACCESSORIES

- A. Provide components of joint firestopping 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

3.01 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.

3.02 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping 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.
- C. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.03 INSTALLATION

- A. General: Install joint firestopping 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 joint firestopping 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.

3.04 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches 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.

3.05 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.
- 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.

3.06 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 joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION

SECTION 07 9200 JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Mildew-resistant joint sealants.
 - 4. Latex joint sealants.
- B. Related Requirements:
 - 1. Section 07 9219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
 - 2. Section 32 1373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Joint sealants.
 - 2. Joint-sealant backing materials.
- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Manufacturers' special warranties.
- B. Installer's special warranties.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.07 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.08 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.
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.

1.09 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 Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. 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

2.01 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

2.02 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.

2.03 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
- B. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- C. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

2.04 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, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.05 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.06 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; 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 C1330, Type C (closed-cell material with a surface skin), 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.

2.07 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: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 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.

3.02 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.
 - 3. Remove laitance and form-release agents from concrete.
 - 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.

3.03 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 C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type 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 Nonsag 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 in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.04 FIELD QUALITY CONTROL

3.05 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.

3.06 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

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SECTION 07 9513.13
INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- B. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).
- D. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. Section Includes:
 - 1. Floor expansion joint covers.
 - 2. Wall expansion joint covers.
 - 3. Ceiling expansion joint covers.

1.03 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
 - 1. Floor expansion joint covers.
 - 2. Wall expansion joint covers.
 - 3. Ceiling expansion joint covers.
- B. Shop Drawings: For each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by 6 inches long in size.
- D. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.
- E. Samples for Verification: For each type of expansion joint cover assembly, full width by 6 inches long in size.
- F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion joint cover assembly.
 - 2. Expansion joint cover assembly location cross-referenced to Drawings.
 - 3. Nominal, minimum, and maximum joint width.
 - 4. Movement direction.
 - 5. Materials, colors, and finishes.
 - 6. Product options.
 - 7. Fire-resistance ratings.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.05 MOCKUPS

PART 2 PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Furnish units in longest practicable lengths to minimize field splicing.
- B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Expansion joint cover assemblies to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.
 - 1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies to be subjected to hose stream testing.

2.03 FLOOR EXPANSION JOINT COVERS

- A. Glide-Plate Floor Joint Cover: Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Construction Specialties, Inc.](#)
 - b. [MM Systems Corporation](#).
 - c. [inpro Corporation](#).
 - 2. Application: Floor to floor.
 - 3. Installation: Recessed.
 - 4. Load Capacity:
 - a. Uniform Load: 50 lb/sq. ft..
 - b. Concentrated Load: 300 lb.
 - c. Maximum Deflection: 0.0625 inch.
 - 5. Fire-Resistance Rating: Not less than 2 hours.
 - 6. Exposed Metal:
 - a. Aluminum: Manufacturer's standard.

2.04 WALL EXPANSION JOINT COVERS

- A. Elastomeric-Seal Wall Joint Cover: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Construction Specialties, Inc.](#)
 - b. [MM Systems Corporation](#).
 - c. [inpro Corporation](#).
 - 2. Application: Wall to wall and I Wall to corner.
 - 3. Fire-Resistance Rating: Not less than that of adjacent construction.
 - 4. Exposed Metal:
 - a. Aluminum: Manufacturer's standard.
 - 5. Seal: Preformed elastomeric membranes or extrusions.
 - a. Color: As selected by Architect from manufacturer's full range.

2.05 CEILING EXPANSION JOINT COVERS

- A. Elastomeric-Seal Ceiling Joint Cover: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Construction Specialties, Inc.](#)
 - b. [MM Systems Corporation.](#)
 - c. [inpro Corporation.](#)
 2. Application: Ceiling to ceiling and Wall to ceiling.
 3. Fire-Resistance Rating: Not less than that of adjacent construction.
 - a. Aluminum: Manufacturer's standard.
 4. Seal: Preformed elastomeric membranes or extrusions.
 - a. Color: As selected by Architect from manufacturer's full range.
- B. Elastomeric-Seal Acoustical Ceiling Joint Cover: Elastomeric-seal assembly designed for use in acoustical ceilings.
1. Application: Ceiling to ceiling and Wall to ceiling.
 2. Seal: Preformed elastomeric membranes or extrusions.
 - a. Color: As selected by Architect from manufacturer's full range.

2.06 MATERIALS

- A. Aluminum: ASTM B221, Alloy 6063-T5 for extrusions; ASTM B209, Alloy 6061-T6 for sheet and plate.
 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.
- D. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.07 ACCESSORIES

- A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.
 1. Provide where indicated on Drawings.
- B. Manufacturer's standard attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction

indicated and to provide for secure attachment of expansion joint cover assemblies.

3.03 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.
 - 1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
 - 2. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 - 3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
 - 5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
 - 1. Provide in continuous lengths for straight sections.
 - 2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 - 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.
- F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.
 - 1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
- G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.04 PROTECTION

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

END OF SECTION

**SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Interior standard steel doors and frames.
 - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 7100 "Door Hardware" for door hardware for hollow-metal doors.

1.02 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.03 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.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance 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 electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 7. Details of anchorages, joints, field splices, and connections.
 - 8. Details of accessories.
 - 9. Details of moldings, removable stops, and glazing.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 - 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
 - 3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly fire-rated borrowed-lite assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.
- C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

- D. Field quality control reports.

1.07 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented 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 doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
1. Ceco Door; AADG, Inc.; ASSA ABLOY.
 2. Curries, AADG, Inc.; ASSA ABLOY Group.
 3. Custom Metal Products.
 4. Steelcraft; Allegion plc.
 5. West Central Manufacturing, Inc.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 3. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- B. Fire-Rated, Borrowed-Lite Assemblies: 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 in accordance with NFPA 257 or UL 9.
- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.37 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A..
 - 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Core: Manufacturer's standard.
 - g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated and temperature-rise-rated doors.
 - 2. Frames:
 - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: Full profile welded.
 - 3. Exposed Finish: Prime.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A..
 - 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A60 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Polyisocyanurate.
 - 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A60 coating.
 - b. Construction: Full profile welded.
 - 3. Exposed Finish: Prime.

2.05 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.06 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Post installed Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.07 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. 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.
- F. Mineral-Fiber Insulation: ASTM C665, 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 E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 08 8000 "Glazing."

2.08 FABRICATION

- A. Door 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 beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Sidelite and 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 welding.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. 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.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
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. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.09 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 ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 EXECUTION

3.01 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. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with NAAMM-HMMA 840.
 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
 3. Floor Anchors: 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.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 1. Non-Fire-Rated Steel Doors: Comply with NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.

2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80, and with undercut clearances as scheduled.
 3. Smoke-Control Doors: Install doors in accordance with NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 8000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

3.04 REPAIR

- A. 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.

END OF SECTION

**SECTION 08 1416
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Five-ply flush wood veneer-faced doors for transparent finish.
 - 2. Fire-rated wood door frames.
 - 3. Factory finishing flush wood doors.
 - 4. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Requirements:
 - 1. Section 08 8000 "Glazing" for glass view panels in flush wood doors.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Door core materials and construction.
 - 2. Door edge construction
 - 3. Door face type and characteristics.
 - 4. Door louvers.
 - 5. Door trim for openings.
 - 6. Door frame construction.
 - 7. Factory-machining criteria.
 - 8. Factory- finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
 - 1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
 - 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
 - 3. Details of frame for each frame type, including dimensions and profile.
 - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 5. Dimensions and locations of blocking for hardware attachment.
 - 6. Dimensions and locations of mortises and holes for hardware.
 - 7. Clearances and undercuts.
 - 8. Requirements for veneer matching.
 - 9. Doors to be factory finished and application requirements.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Special warranties.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.07 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. 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 temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
 - 2. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during remainder of construction period.

1.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors and frames.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain flush wood doors from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.03 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.
 - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.04 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Lambton Doors](#).
 - b. Masonite Architectural.
 - c. [Oshkosh Door Company](#).
 - d. [VT Industries, Inc.](#)
 2. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
 3. ANSI/WDMA I.S. 1A Grade: Premium.
 4. Faces: Single-ply wood veneer not less than 1/50 inch thick.
 - a. Species: Cherry
 - b. Cut: Rift Cut
 - c. Match between Veneer Leaves: Book match.
 - d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - f. Room Match:
 - 1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
 - 2) Provide door faces of compatible color and grain within each separate room or area of building.
 - g. Transom Match: Continuous match.
 - h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064216 "Flush Wood Paneling."
 5. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.
 - (a) Finish steel edges and astragals to match door hardware (locksets or exit devices).
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
 6. Core for Non-Fire-Rated Doors:
 - a. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
 7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) 5-inch midrail blocking, in doors indicated to have exit devices.

8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.05 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: Manufacturer's standard shape.
 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.

2.06 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 5. 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 08 8000 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.

2.07 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 2. Finish faces, all four edges, edges of cutouts, and mortises.
 3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Factory finish doors that are indicated on Drawings to receive transparent finish.
- D. Factory finish doors where indicated in schedules or on Drawings as factory finished.
- E. Transparent Finish:
 1. ANSI/WDMA I.S. 1A Grade: Premium.
 2. Staining: Match WPC-1
 3. Sheen: Satin.

PART 3 EXECUTION

3.01 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.

3.02 INSTALLATION

- A. Hardware: For installation, see Section 08 7100 "Door Hardware."
- B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
 3. Install fire-rated doors and frames in accordance with NFPA 80.
 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 FIELD QUALITY CONTROL

3.04 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

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SECTION 08 4113
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure; 2017.
- B. AAMA 701/702 - Performance Specification for Pile Weatherstrips (AAMA 701) and Polymer Weatherseals (AAMA 702); 2023.
- C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- F. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- G. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2023a.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- J. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- K. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.
- L. ASTM C1401 - Standard Guide for Structural Sealant Glazing; 2023.
- M. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018.
- N. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2023.
- O. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2023.
- P. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- Q. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).
- R. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
- S. ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation; 2022.
- T. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials; 2019.

- U. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2023.
- V. BHMA A156.3 - Exit Devices; 2020.
- W. BHMA A156.21 - Thresholds; 2019.
- X. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- Y. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- Z. UL 305 - Standard for Panic Hardware; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.
- B. Related Requirements:
 - 1. Section 08 4126 "All-Glass Entrances and Storefronts" for systems without aluminum support framing.

2.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

2.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- 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 type of 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.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- F. 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.

2.04 INFORMATIONAL SUBMITTALS

- A. Certificates:
 - 1. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - a. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- B. Test and Evaluation Reports:
 - 1. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by qualified testing agency.
- C. Qualification Statements:
 - 1. For Installer.
- D. Sample warranties.

2.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For aluminum-framed entrances and storefronts.

2.06 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installers: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

2.07 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
 - 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.

2.08 PRECONSTRUCTION TESTING

2.09 WARRANTY

- A. Special Warranty: Manufacturer 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, Factory-Applied Finishes: 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 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - 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

3.01 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

3.02 PERFORMANCE REQUIREMENTS

- A. 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, 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.
- B. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: .
- C. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
 - 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.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Limited to 2L/175 at unsupported cantilevers.
- D. Structural: Test in accordance with ASTM E330/E330M as follows:
 - 1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and 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.
- E. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
- F. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
 2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.45 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 - b. Entrance Doors: U-factor of not more than 0.83 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.
 - b. Entrance Doors: SHGC of not more than 0.25 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283.
 - b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
- H. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.
 1. Outdoor-Indoor Transmission Class: Minimum 26.
- I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 4 for basic protection.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, 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 in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 75 deg F.

3.03 STOREFRONT SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide [Kawneer Company, Inc.](#); [Arconic Corporation](#); 451T or a comparable product by one of the following:
 1. OldCastle BuildingEnvelope (OBE); Series 3000XT.
 2. [U.S. Aluminum](#); [C.R. Laurence Co., Inc.](#); [CRH Americas, Inc.](#); 451SF.
 3. [YKK AP America Inc.](#); 45 TU

- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Exterior Framing Construction: Thermally broken.
 - 2. Interior Vestibule Framing Construction: Thermally broken.
 - 3. Glazing System: Retained mechanically with gaskets on four sides.
 - 4. Glazing Plane: Front.
 - 5. Finish: High-performance organic finish.
 - 6. Fabrication Method: Field-fabricated stick system.
 - 7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 8. Steel Reinforcement: As required by manufacturer.
- C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

3.04 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, 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.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 - 2. Door Design: Wide stile; 5-inch nominal width.
 - 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 - 4. Finish: Match adjacent storefront framing finish.

3.05 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 for each entrance door, to comply with requirements in this Section.
 - 1. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 - 2. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion.
 - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- C. Removable Mullions: BHMA A156.3 extruded aluminum.
 - 1. When used with panic exit devices, provide keyed removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305. Use only mullions that have been tested with exit devices to be used.
- D. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
 - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

- E. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- F. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

3.06 GLAZING

- A. Glazing: Comply with Section 08 8000 "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.

3.07 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: 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 in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

3.08 ACCESSORIES

- A. Automatic Door Operators: Section 08 7113 "Power Door Operators."
- B. 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.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch 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 A123/A123M or ASTM A153/A153M requirements.
- D. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC filler.

3.09 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 exterior.
 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. Storefront Framing: Fabricate components for assembly using shear-block system.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- G. 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.
- H. 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.
- I. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

3.10 ALUMINUM FINISHES

- A. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: Match STEM Building

3.11 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

4.01 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.

4.02 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. 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.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

4.03 INSTALLATION OF OPERABLE UNITS

- A. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

4.04 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 08 8000 "Glazing."

4.05 INSTALLATION OF STRUCTURAL GLAZING

- A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
- B. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
- C. Set glazing with proper orientation so that coatings face exterior or interior as specified.
- D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.
- E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer and framing manufacturer's written instructions and in compliance with local codes.
- F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
- G. Allow structural sealant to cure in accordance with manufacturer's written instructions.
- H. Clean and protect glass as indicated in Section 088000 "Glazing."

4.06 INSTALLATION OF WEATHERSEAL SEALANT

- A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.
- B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

4.07 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

- A. Install entrance 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 in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

4.08 ERECTION TOLERANCES

- A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:

- a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

4.09 FIELD QUALITY CONTROL

END OF SECTION

SECTION 08 7100 DOOR HARDWARE

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2020.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- D. BHMA A156.1 - Standard for Butts and Hinges; 2021.
- E. BHMA A156.2 - Bored and Preamsembled Locks and Latches; 2022.
- F. BHMA A156.3 - Exit Devices; 2020.
- G. BHMA A156.4 - Door Closers and Pivots; 2024.
- H. BHMA A156.5 - Cylinders and Input Devices for Locks; 2020.
- I. BHMA A156.6 - Standard for Architectural Door Trim; 2021.
- J. BHMA A156.8 - Door Controls - Overhead Stops and Holders; 2021.
- K. BHMA A156.13 - Mortise Locks & Latches Series 1000; 2022.
- L. BHMA A156.14 - Sliding and Folding Door Hardware; 2024.
- M. BHMA A156.16 - Standard for Auxiliary Hardware; 2023.
- N. BHMA A156.18 - Standard for Materials and Finishes; 2020.
- O. BHMA A156.21 - Thresholds; 2019.
- P. BHMA A156.22 - Standard for Gasketing; 2021.
- Q. BHMA A156.26 - Standard for Continuous Hinges; 2021.
- R. BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems; 2023.
- S. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- T. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- U. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.
- V. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- W. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- X. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. Section Includes:
 - 1. Mechanical door hardware for the following:
 - a. Swinging doors.
 - 2. Cylinders for door hardware specified in other Sections.
 - 3. Electrified door hardware.
- B. Related Requirements:
 - 1. Section 081113 "Hollow Metal Doors and Frames."
 - 2. Section 081416 "Flush Wood Doors."
 - 3. Section 123661 "Metal Laboratory Casework" for cabinet door hardware provided with cabinets.

1.03 COORDINATION

- A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.
 - 1. Cast anchoring inserts into concrete.
- B. 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.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.04 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.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of electrified door hardware.
 - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

- B. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware schedule.

1.07 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.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.08 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.

1.09 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

2.01 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.

2.02 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 in accordance with NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. 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.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2010 ADA Standards for Accessible Design" and the 2012 Texas Accessibility Standards.
 - 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. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
 - c. 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 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.

2.03 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 - 1. Ives.
 - 2. Hager.

2.04 CONTINUOUS HINGES

- A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
- B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
 - 1. Ives.
 - 2. Hager.

2.05 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
- C. Lock Backset: 2-3/4 inches unless otherwise indicated.

- D. Lock Trim:
 - 1. Description: As indicated on Drawings.
 - 2. Levers: Cast.
 - a. Best Locks 93K
 - b. Schlage L Locks
 - 3. Escutcheons (Roses): Cast.
 - 4. Dummy Trim: Match lever lock trim and escutcheons.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
 - 4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.
- F. Mortise Locks: BHMA A156.13; Operational Grade 1; Series Schlage L
 - 1. Schlage L Locks.
- G. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
 - 1. Best Lock

2.06 SELF-LATCHING FLUSH BOLTS

- A. Self-Latching Flush Bolts: BHMA A156.3, Type 27; minimum 3/4-inch (19-mm) throw; with dust-proof strikes; designed for mortising into door edge. Include wear plates.
 - 1. Ives.
 - 2. Quality.
 - 3. Trimco.

2.07 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.
 - 1. Von Duprin 33/99 - No Substitution.

2.08 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
 - 1. Core Type: Interchangeable.
- C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.09 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. No Master Key System: Only change keys operate cylinders.
 - a. Provide three cylinder change keys.
 - 2. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three cylinder change keys and five master keys.
 - 3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
 - a. Provide three cylinder change keys and five each of master and grand master keys.

4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
 - a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.
 5. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
 6. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.

2.10 KEY CONTROL SYSTEM

2.11 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; aluminum, unless otherwise indicated.
1. Von Duprin 996L - No substitution.

2.12 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
- B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: BHMA A156.22.

2.13 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
1. LCN 4040XP - No substitution.

2.14 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.
1. Glynn-Johnson.
 2. Ives.
 3. Quality.

2.15 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.
1. Glynn-Johnson.

2.16 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
1. Zero International.
 2. Pemko.
 3. Reese Metal Weatherstripping.
- B. Maximum Air Leakage: When tested in accordance with ASTM E283 with tested pressure differential of 0.3-inch wg (75 Pa), as follows:
1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.

2. Gasketing on Single Doors: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.
3. Gasketing on Double Doors: 0.50 cfm per ft. (0.000774 cu. m/s per m) of door opening.

2.17 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
 1. Zero International.
 2. Pemko.
 3. Reese Metal Weatherstripping.

2.18 SLIDING DOOR HARDWARE

- A. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated. Reference Specification section 083400.

2.19 AD SYSTEMSFOLDING DOOR HARDWARE

- A. General: BHMA A156.14; complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.

2.20 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 1. Ives
 2. Baldwin Hardware Manufacturing Corporation

2.21 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; use threaded-to-the-head wood screws for wood doors and 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.

2.22 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

3.01 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.

3.02 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.03 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 finishes have been completed on substrates involved.
 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 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 of door height greater than 90 inches.
- E. Lock Cylinders: Owner will install all permanent cores. Contractor should request keying instructions from UNT Access Control a minimum of eight (8) weeks in advance of installation

to provide factory pin cores for UNT. Contractor should order and deliver uncut keys and uncombined cores to UNT Facilities for orders of 20 or fewer cores.

- 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. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- I. 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.
- J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: 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.

3.05 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.
- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.06 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.

3.07 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.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.09 DOOR HARDWARE SCHEDULE

122034 OPT0395998 VERSION 2

HW SET# 501TW

DOOR #(S):

D171		D271		D272		D274			
QTY		DESCRIPTION	CATALOG NUMBER				FINISH	MFR	
4	EA	HINGE	5BB1HW 5 X 4.5	<input type="checkbox"/>			652	IVE	
1	EA	CLASSROOM LOCK	93K-7R-15D-S3				626	BES	
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>			626	SCH	
1	EA	SURFACE CLOSER	4040XP RW/PAX MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>			689	LCN	
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>			630	IVE	
1	EA	WALL STOP	WS406/407CCV	<input type="checkbox"/>			630	IVE	
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	<input type="checkbox"/>			BK	ZER	

HW SET# CE201CTW

DOOR #(S):

D170.2		D170C		D270.2					
QTY		DESCRIPTION	CATALOG NUMBER				FINISH	MFR	
4	EA	HINGE	5BB1HW 5 X 4.5	<input type="checkbox"/>			652	IVE	
1	EA	STOREROOM LOCK	93K-7D-15D-S3				626	BES	
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>			626	SCH	
1	EA	ELECTRIC STRIKE	6211-FSE (FAIL SECURE) VOLTAGE	<input type="checkbox"/>	~		630	VON	

			AS REQ				
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>		630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	<input type="checkbox"/>		BK	ZER
1	EA	MULTITECH READER	MTMS15	<input type="checkbox"/>	~	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	<input type="checkbox"/>	~	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	<input type="checkbox"/>	~	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	<input type="checkbox"/>	~	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
 -FREE EGRESS BY LEVER.
 -COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
 -OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HW SET# CE201TW

DOOR #(S):

D160		D170.1		D270.1			
QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5	<input type="checkbox"/>		652	IVE
1	EA	STOREROOM LOCK	93K-7D-15D-S3			626	BES
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH

1	EA	ELECTRIC STRIKE	6211-FSE (FAIL SECURE) VOLTAGE AS REQ	<input type="checkbox"/>	~	630	VON
1	EA	SURFACE CLOSER	4040XP RW/PAX MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>		630	IVE
1	EA	WALL STOP	WS406/407CCV	<input type="checkbox"/>		630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	<input type="checkbox"/>		BK	ZER
1	EA	MULTITECH READER	MTMS15	<input type="checkbox"/>	~	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	<input type="checkbox"/>	~	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	<input type="checkbox"/>	~	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	<input type="checkbox"/>	~	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HW SET# CE205TW

DOOR #(S):

CD200.2							
QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 NRP	<input type="checkbox"/>		630	IVE
1	EA	STOREROOM LOCK	93K-7D-15D-S3			626	BES
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH

1	EA	ELECTRIC STRIKE	6211-FSE (FAIL SECURE) VOLTAGE AS REQ	<input type="checkbox"/>	~	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>		630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	<input type="checkbox"/>		AA	ZER
1	EA	GASKETING	328AA H & J	<input type="checkbox"/>		AA	ZER
1	EA	DOOR SWEEP	8198AA	<input type="checkbox"/>		AA	ZER
1	EA	THRESHOLD	65A	<input type="checkbox"/>		A	ZER
1	EA	MULTITECH READER	MTMS15	<input type="checkbox"/>	~	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	<input type="checkbox"/>	~	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	<input type="checkbox"/>	~	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	<input type="checkbox"/>	~	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
 -FREE EGRESS BY LEVER.
 -COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
 -OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HW SET# CE711CTW

DOOR #(S):

CD100	D200					
QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR

4	EA	HINGE	5BB1HW 5 X 4.5	<input type="checkbox"/>		652	IVE
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-L-NL-06-CON 24 VDC	<input type="checkbox"/>	~	626	VON
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH
1	EA	RIM CYLINDER	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH
1	EA	ELECTRIC STRIKE	6300-FSE (FAIL SECURE) VOLTAGE AS REQ	<input type="checkbox"/>	~	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>		630	IVE
3	EA	SILENCER	SR64	<input type="checkbox"/>		GRY	IVE
1	EA	MULTITECH READER	MTMS15	<input type="checkbox"/>	~	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	<input type="checkbox"/>	~	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	<input type="checkbox"/>	~	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	<input type="checkbox"/>	~		VON

- INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
- FREE EGRESS BY THE PUSH PAD.
- COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
- OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HW SET# CE715TW

DOOR #(S):

CD100.2

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 NRP	<input type="checkbox"/>		630	IVE
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-L-NL-06-CON 24 VDC	<input type="checkbox"/>	~	626	VON
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH
1	EA	RIM CYLINDER	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH
1	EA	ELECTRIC STRIKE	6300-FSE (FAIL SECURE) VOLTAGE AS REQ	<input type="checkbox"/>	~	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	<input type="checkbox"/>		630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)	<input type="checkbox"/>		AA	ZER
1	EA	GASKETING	328AA H & J	<input type="checkbox"/>		AA	ZER
1	EA	DOOR SWEEP	8198AA	<input type="checkbox"/>		AA	ZER
1	EA	THRESHOLD	65A	<input type="checkbox"/>		A	ZER

1	EA	MULTITECH READER	MTMS15	<input type="checkbox"/>	~	BLK	SCE
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	<input type="checkbox"/>	~	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	<input type="checkbox"/>	~	WHT	SCE
1	EA	POWER SUPPLY	PS902 900- 2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	<input type="checkbox"/>	~		VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.

-FREE EGRESS BY THE PUSH PAD.

-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.

-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HW SET# CY200C1T

DOOR #(S):

D170.3							
QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
7	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8	<input type="checkbox"/>	~	652	IVE
1	EA	EU STOREROOM LOCK	93K-7DEU-15D- S3		~	626	BES
1	EA	PERMANENT CORE	MATCH EXISTING KEY SYSTEM	<input type="checkbox"/>		626	SCH
1	EA	COORDINATOR	COR X FL X MB X HW PREPS	<input type="checkbox"/>		628	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
1	EA	SURFACE CLOSER	4040XP RW/PA X MTG BRKT, SPCR & PLATE AS REQ	<input type="checkbox"/>		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	<input type="checkbox"/>		630	IVE

1	EA	WALL STOP	WS406/407CCV <input type="checkbox"/>		630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS) <input type="checkbox"/>		BK	ZER
1	SET	MEETING STILE	8193AA (2 PCS - 1 SET) (OMIT @ NON-RATED DOORS) <input type="checkbox"/>		AA	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ	~		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS	~		SCH
2	EA	MULTITECH READER	MTMS15 <input type="checkbox"/>	~	BLK	SCE
2	EA	DOOR CONTACT	679-05 TYPE AS REQ <input type="checkbox"/>	~	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ) <input type="checkbox"/>	~	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
 -FREE EGRESS BY CARD READER AND LEVER.
 -EGRESS CARD READER FOR AUDITING PURPOSES.
 -COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
 -OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

END OF SECTION

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**SECTION 08 8000
GLAZING**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section includes:
 - 1. Glass for glazed storefront at hydroponic enclosure and banquette seating .
 - 2. Glazing sealants and accessories.

1.04 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.

1.05 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.06 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.

1.07 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, including the following products; 12 inches square.
 - 1. Laminated glass.
- C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

1.08 QUALITY ASSURANCE

- A. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- B. Mockups: Build mockups 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.

1.09 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.

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 degrees Fahrenheit .

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:
 - 1. Cardinal Glass Industries.
 - 2. Guardian Industries Corp.; SunGuard.
 - 3. Pilkington North America.
 - 4. PPG Industries, Inc.
 - 5. Viracon, Inc.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 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. Safety Glazing: Provide glazing that complies with 16 CFR 1201, Category II.

2.03 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."
- 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. 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.
- D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass. Where fully

tempered float glass is indicated, provide fully tempered float glass.

2.04 GLASS PRODUCTS

- A. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
 - 1. Basis-of-Design Product: PPG; "Starphire."
- B. 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.

2.05 LAMINATED GLASS

- A. 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.
 - 1. Construction: Laminate glass with polyvinyl butyral interlayer,, to comply with interlayer manufacturer's written instructions.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear.

2.06 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. Field-applied sealants shall have a VOC content of not more than 250 g/L.
 - 4. 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 50, Use NT.

2.07 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.

2.08 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.

- 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 (arris edge).
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 EXECUTION

3.01 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. Minimum required face and edge clearances.
 - 3. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 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.

3.03 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 .
 - 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 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.

3.04 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.

3.05 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.

3.06 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.

3.07 MONOLITHIC GLASS SCHEDULE

- A. Glass Type GL-1: Ultraclear fully tempered float glass.
 - 1. Basis-of-Design Product: PPG Industries, Inc.; Starphire.
 - 2. Minimum Thickness: 0.24 inch.

3. Safety glazing required.

3.08 LAMINATED GLASS SCHEDULE

- A. Glass Type LGL-1: Clear laminated glass with two plies of ultraclear fully tempered float glass.
 1. Product: Dining Partition and Hydroponic Enclosure Glazing.
 2. Minimum Thickness of Each Glass Ply: As indicated, 0.24 inch and 0.39 inch.
 3. Interlayer Thickness: 0.045 inch.
 4. Safety glazing required.

END OF SECTION

SECTION 09 2116.23
GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- B. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- C. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- D. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- E. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- F. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- G. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- H. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.
- I. ICC-ES AC70 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements; 2019, with Editorial Revision (2021).
- J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Gypsum board shaft wall assemblies.

1.04 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.05 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.

1.06 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

2.01 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 E119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.

2.02 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated on Drawings.
- B. STC Rating: 51, minimum.
- C. Gypsum Shaftliner Board:
 - 1. Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch thick, with double beveled long edges.
- D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
 - 1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- E. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:
 - 1. Depth: As indicated.
 - 2. Minimum Base-Metal Thickness: 0.033 inch.
- F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
- G. 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.
- H. Finish Panels: Gypsum board as specified in Section 09 2900 "Gypsum Board."
- I. Sound Attenuation Blankets: As specified in Section 09 2900 "Gypsum Board."

2.03 AUXILIARY MATERIALS

- A. 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 09 2900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
- C. Steel Drill Screws: ASTM C1002 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 E488/E488M 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 E1190 conducted by a qualified testing agency.

- E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch minimum thickness of base metal (uncoated).
- F. Acoustical Sealant: Section 07 9219 "Acoustical Joint Sealants."

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fire Protection."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.03 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 at locations indicated on Drawings 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. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.04 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

**SECTION 09 2216
NON-STRUCTURAL METAL FRAMING**

PART 1 GENERAL

1.01 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.
- B. Related Requirements:
 - 1. Section 05 4000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.04 QUALITY ASSURANCE

- A. 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.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 PRODUCTS

2.01 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 E119 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 E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For composite wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 5 lbf/sq. ft..
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. minimum as required by the IBC.

2.02 FRAMING SYSTEMS

- A. Framing Members, General: Comply with AISI S220 for conditions indicated.
 - 1. Steel Sheet Components: Comply with AISI S220 requirements for metal unless otherwise indicated
 - 2. Protective Coating: Comply with AISI S220; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.

- a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.
- B. Studs and Track: AISI S220.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch.
 - 2. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. 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. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of 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.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch.
 - 2. Depth: As indicated on Drawings.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.03 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-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 AC308 as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - c. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
 - 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

2.04 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.
- B. Isolation Strip at Exterior Walls: Provide the following:
 - 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 EXECUTION

3.01 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.

3.02 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.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 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.

3.04 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: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. 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. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

- a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. 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.
4. 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.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:
 1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.05 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.
- 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, countersplaying, 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.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 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.
- 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 measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

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SECTION 09 2900 GYPSUM BOARD

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.04 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.

1.05 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, 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, those that are moisture damaged, and those that are 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

2.01 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.

2.02 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.

2.03 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Georgia-Pacific Gypsum LLC.
 - a. Interior Partitions and Ceilings: ToughRock® Mold-Guard™
 - 2. National Gypsum Company.
 - a. Interior Partitions and Ceilings Gold Bond® XP® Gypsum Board
 - 3. USG Corporation.

- a. Interior Partitions and Ceilings: Sheetrock® Brand Mold Tough® Gypsum Panels
- B. Gypsum Wallboard: Type X: ASTM C 1396
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Impact-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 2.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10.

2.04 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Vinyl complying with ASTM D-1784.
 - 2. Shapes: Provide vinyl trim with perforated flanges for embedding in finishing compound. Provide in the following shapes or as shown:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Premanufactured Moldings: Provide metal molding at installations as indicated in Drawings.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. Pittcon Industries.
 - 3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
 - 4. Finish: As indicated on the drawings
 - 5. Accessories: Factory-fabricated corner, intersection, and door frame closure trim pieces.

2.05 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 - 3. 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 setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping 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 or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Tile Backing Panels:
 - 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.06 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. 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 thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. 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.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- 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.

3.02 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 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.
- 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. 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- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- 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. 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 recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.03 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: Vertical surfaces unless otherwise indicated.
 - 2. Abuse-Resistant Type: Corridor side of partitions, and 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 vertically (parallel 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-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 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-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 and face layers separately to supports with screws.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.04 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at showers, floor sinks, wet areas in kitchen and where indicated.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 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. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.
 - 4. U-Bead: Use at exposed panel edges where indicated.
- C. Aluminum Trim: Install in locations indicated on Drawings.

3.06 SOUND CONTROL CEILING INSTALLATION

- A. Install panels to suspension system with joints staggered and with 3/8" gap at perimeter.
- B. Finish Level: Level 2, where concealed by suspended ceiling below.
- C. Finish Level: Level 5, where panels are exposed to view as finished ceiling.
- D. Seal the perimeter joint with acoustical sealant.
- E. When an acoustical tile ceiling is to be used below the sound barrier ceiling, continue the hanger wires to the acoustical ceiling and caulk all hanger wire penetrations where they pass through the gypsum ceiling.
- F. Where mechanical equipment, pipes or ducts fall below the barrier ceiling, provide additional hangers that are not connected to the barrier ceiling for this equipment and sponge sleeves where penetrations pass through the barrier ceiling. Seal the perimeter of penetrations and sleeves with acoustical sealant.

3.07 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. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. 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 or applied finish panel surfaces.
 - 3. Level 5: All exposed locations
 - a. Primer and its application to surfaces are specified in other Division 09 Sections.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.08 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

**SECTION 09 5113
ACOUSTICAL PANEL CEILINGS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes 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.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Samples for Initial Selection: For components with factory-applied finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Panels: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension-system members.
 - 2. Structural members to which suspension systems will be attached.
 - 3. 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.
 - 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
 - 5. Size and location of initial access modules for acoustical panels.
 - 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
- B. Qualification Data: For testing agency.
- C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.07 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. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.

1.08 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical ceiling area as shown on Drawings.
 - 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.

1.09 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.

1.10 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.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 450 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.03 ACOUSTICAL PANELS APC-1

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Rockfon, Sonar 16290 or a comparable product by one of the following:
 - 1. Or alternate if approved by Architect prior to bidding
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise

indicated.

- C. Color: White.
- D. Light Reflectance (LR): Not less than 0.85.
- E. Ceiling Attenuation Class (CAC): Not less than 35.
- F. Noise Reduction Coefficient (NRC): Not less than 0.85.
- G. Articulation Class (AC): Not less 190.
- H. Edge/Joint Detail: Square Tegal Narrow
- I. Thickness: 1.5 inch.
- J. Modular Size: 24 by 24 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 D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.04 SEAMLESS ACOUSTIC PANEL GCP-2

- A. Acoustical Panels for Attachment to Metal Framing: manufacturer's standard stone wool-based acoustical panels manufactured from volcanic rock and low-percentage of binder and monofilament mineral fibers.
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Rockfon, Mono Acoustic TE or a comparable product by one of the following:
 - 1. Or alternate if approved by Architect prior to bidding
- C. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- D. Color: White.
- E. Light Reflectance (LR): Not less than 0.87.
- F. Ceiling Attenuation Class (CAC): Not less than 35.
- G. Noise Reduction Coefficient (NRC): Not less than 0.95.
- H. Articulation Class (AC): Not less 190.
- I. Edge/Joint Detail: Tapered for seamless finishing
 - 1. Joints: Manufacturer's standard joint tape and joint compound.
- J. Thickness: 1.5 inch.
- K. Modular Size: 24 by 71 inches.

2.05 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
- B. 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 coating designation; with prefinished 9/16-inch-wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: butt-edge type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Cold-rolled steel.
 - 5. Cap Finish: Painted white.

2.06 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. 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 according to ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled bonded anchors.
 - b. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 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 according to ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
 - 1. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
 - 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch-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 wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

2.07 JOINT TREATMENT MATERIALS

- A. Material standard, generally: Conform to ASTM C475.
- B. Joint Tape: Manufacturer's standard 40mm (~1-5/8 inch.) wide joint tape.
- C. Joint Compound: Manufacturer's standard powder filler, mixed with water at jobsite in accordance with manufacturer's instructions. For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
- D. Finish Render: Manufacturer's standard acoustically transparent white, water-based spray-applied texture.

2.08 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 07 9219 "Acoustical Joint Sealants."

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
 - 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 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 o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches 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 o.c. and not more than 3 inches 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. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 - 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.04 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.05 FIELD QUALITY CONTROL

3.06 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

**SECTION 09 6513
RESILIENT BASE AND ACCESSORIES**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.
 - 2. Rubber molding accessories.
- B. Related Requirements:
 - 1. Section 09 6519 "Resilient Sheet Flooring" for rubber base integral with rubber sheet flooring.

1.02 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 12 inches long.
- C. Product Schedule: For resilient base and accessory products.

1.03 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. 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.

1.04 QUALITY ASSURANCE

- A. 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.
 - 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.

1.05 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.

1.06 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

2.01 THERMOPLASTIC-RUBBER BASE RB-1

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexco.
 - 2. Johnsonite; a Tarkett company.
 - 3. Roppe Corporation.
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Standard Cove
- C. Thickness: 0.25 inch.
- D. Height: 4inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job-formed .
- G. Inside Corners: Job-formed.
- H. Colors: 699 Battleship

2.02 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.
- C. Metal Edge Strips: Extruded aluminum with mill finish, nominal 2 inches wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 EXECUTION

3.01 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.

3.02 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 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.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 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.
- 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. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Cope corners to minimize open joints.

3.04 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.

3.05 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 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

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**SECTION 09 6519
RESILIENT TILE FLOORING**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- D. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.
- E. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
- F. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Rubber floor tile.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: Full-size units of each color, texture, and pattern of floor tile required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
- D. Welded-Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to a rigid backing and prepared by Installer for this Project.
- E. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.07 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. Floor Tile (Rubber used in Laboratories) : Furnish one box for every 20 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.10 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 floor tile 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. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, 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.
- B. [Flooring products shall comply with](#) the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 RUBBER FLOOR TILE – RF-1, RF-2

- A. Tile Standard: ASTM F1344, Class I-B, Homogeneous Rubber Tile, through mottled.
- B. Hardness: Grade 1, minimum hardness of 85, measured using Shore, Type A durometer according to ASTM D2240.
- C. Wearing Surface: Textured.
- D. Thickness: 14 inches.
- E. Size: 40" x 40" nominal.
- F. Seamless-Installation Method: Heat welded.
- G. Colors and Patterns: To be selected by architect from manufacturers standard range.

2.03 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. [Adhesives shall have a VOC](#) content of 50 g/L or less.
 - 2. [Adhesive 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. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Colors: Match floor tile.
- D. Integral-Flash-Cove-Base Accessories:
 - 1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
 - 2. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by resilient sheet flooring manufacturer.
 - 3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.

PART 3 EXECUTION

3.01 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 floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM 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 floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and 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. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install floor tiles 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 floor tile and installation materials into spaces where they will be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.03 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- H. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
- I. Integral-Flash-Cove Base (Rubber Floor Tile): Cove resilient sheet flooring to dimension indicated up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.
 - 1. Install metal corners at inside and outside corners.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION

SECTION 09 9123 INTERIOR PAINTING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM D523 - Standard Test Method for Specular Gloss; 2014 (Reapproved 2018).
- C. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024.
- D. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates. the following interior substrates:
 - 1. Concrete.
 - 2. Concrete masonry units (CMU).
 - 3. Existing Brick
 - 4. Gypsum board.
 - 5. Hollow metal doors and frames.
 - 6. Miscellaneous incidental steel substrates.
- B. Related Requirements:
 - 1. Division 03 Section "Cast-In-Place Concrete" for hardeners and densifiers applied to concrete floors.
 - 2. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
 - 3. Division 06 Sections for shop priming carpentry with primers specified in this Section.
 - 4. Division 09 Sections for high-performance and special-use coatings.
 - 5. Division 09 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.04 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.05 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 draw downs on rigid backing, 8 inches square.
2. 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.

1.06 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: 2 gal. unopened of each material and color applied.

1.07 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 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.

1.08 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.

1.09 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Sherwin-Williams Company (The)
 2. PPG Architectural Finishes, Inc./Glidden
 3. Benjamin Moore & Co.

2.02 PAINT, 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 paint 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.
- 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. 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.
 - 11. Dry Erase Coatings: 250 g/L.
- D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 BLOCK FILLERS

- A. Block Filler, Latex, Interior/Exterior:
 - 1. Benjamin Moore; Moorcraft – Super Craft Latex Block Filler
 - 2. Sherwin Williams; PrepRite – Interior/Exterior Block Filler
 - 3. PPG; Speedhide Interior/Exterior Acrylic Masonry Block Filler 6-15

2.04 PRIMERS/SEALERS

- A. Primer Sealer, Interior, Institutional Low Odor/VOC:
 - 1. Sherwin Williams; ProGreen 200 Interior Latex Primer
 - 2. Benjamin Moore; Eco Spec – Interior Latex Primer Sealer
 - 3. PPG; SpeedHide 6-2
- B. Primer, for Interior Concrete Substrates:
 - 1. Sherwin Williams; Loxon
 - 2. Benjamin Moore; Eco Spec Primer Sealer
 - 3. PPG; Perma-Crete Alkali Resistant Primer 4-603
- C. Primer for interior glossy brick substrates:
 - 1. Sherwin Williams; Extreme Bond Interior/Exterior Bonding Primer
 - 2. Benjamin Moore; Ultra Spec Masonry Acrylic Primer

2.05 METAL PRIMERS

- A. Primer, Rust-Inhibitive, Water Based:
 - 1. Sherwin Williams; Pro Industrial – ProCryl Universal Primer
 - 2. Benjamin Moore; Super Spec High Performance – Acrylic Metal Primer
 - 3. PPG; Pitt-Tech Plus Int/Ext DTM Industrial Primer 90-912

2.06 WATER-BASED PAINTS – ALL PAINT TYPES/FORMULAS SHOULD BE APPROVED BY THE CLIENT PRIOR TO PURCHASE.

- A. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1):
 - 1. Sherwin Williams; ProClassic – Interior Latex Flat
 - 2. Benjamin Moore; Eco Spec – Flat Interior Latex Enamel
 - 3. PPG; Speedhide 6-70 – Interior Latex Flat

- B. Latex, Interior, Institutional Low Odor/VOC, Eggshell (Gloss Level 2):
 - 1. Sherwin Williams; by SuperPaint Air Purifying– Interior Latex Egg-Shell
 - 2. Benjamin Moore; Eco Spec – Eggshell Interior Latex Enamel
 - 3. PPG: Speedhide 6-411 – Interior Latex Egg-Shell
- C. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5):
 - 1. Sherwin Williams; Proclassic – Interior Latex Semi-Gloss (Trim)
 - 2. Sherwin Williams; by SuperPaint Air Purifying Semigloss (Corridors and Classrooms)
 - 3. Benjamin Moore; Eco Spec – Interior Latex Semi-Gloss Enamel
 - 4. PPG; Pure Performance 9-500 – Interior Latex Semi-Gloss
 - 5. Scuffmaster ScrubTough Max – For Elevator Doors and Frames, and paneling at reception desk.

2.07 OIL-BASED PAINTS

- A. Alkyd, Interior, Semi-Gloss:
 - 1. Sherwin Williams; ProMar 200.
 - 2. Benjamin Moore; Dulamel C207.
 - 3. PPG; Speedhide 6-90 Series (Lo Sheen)

2.08 FLOOR COATINGS

- A. Sealer, Water Based, for Concrete Floors:
 - 1. Sherwin Williams: Concrete & Masonry Waterproofing Sealer.
 - 2. PPG: Plex Seal Int./Ext. Clear Sealer.
 - 3. Benjamin Moore: Approved equal.

2.09 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 EXECUTION

3.01 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. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates 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 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. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
- G. 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.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 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.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.

- c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards if indicated on drawings
 - b. Uninsulated metal piping if indicated on drawings
 - c. Uninsulated plastic piping if indicated on drawings
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.05 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.

3.06 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Non-traffic Surfaces:
 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Concrete and masonry primer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (eggshell).
- B. Concrete Substrates, Traffic Surfaces:
 1. Water-Based Clear Sealer System:
 - a. First Coat: Sealer, water based, for concrete floors.
 - b. Topcoat: Sealer, water based, for concrete floors.
- C. CMU Substrates:
 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Interior/exterior latex block filler.

- b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (semigloss).
- D. Steel Substrates, Hollow Metal Doors and Frames:
 - 1. Institutional Alkyd-Based Semi-Gloss Enamel System:
 - a. Prime Coat: Rust-inhibitive primer (for non-primed surfaces).
 - b. Intermediate Coat: Alkyd-based enamel matching topcoat.
 - c. Topcoat: Alkyd-based enamel (semigloss).
- E. Gypsum Board Substrates – Ceilings and Soffits:
 - 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (flat).
- F. Gypsum Board Substrates - Walls:
 - 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (finish as indicated on drawings).

END OF SECTION

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SECTION 10 1423 PANEL SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Panel signage.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures.
- B. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.
- C. Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
- D. Samples: Submit two samples of each type of sign, of size similar to that required for project, indicating sign style, font, and method of attachment.
- E. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Accessibility Requirements: Comply with ADA Standards, TAS Standards, and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.02 PANEL SIGNAGE

- A. Panel Signage:
 - 1. Application: Room and door signs.
 - 2. Description: Flat signs with engraved panel media, tactile characters.
 - 3. Sign Size: 4 inches by 6 inches.
 - 4. Total Thickness: 1/8 inch.
 - 5. Color and Font, unless otherwise indicated:
 - a. Character Font: Helvetica, Arial, or other sans serif font.
 - b. Character Case: Upper and lower case (title case).
 - c. Background Color: As scheduled.
 - d. Character Color: Contrasting color.
 - 6. Material: Laminated colored plastic engraved through face to expose core as background color.
 - 7. Profile: Flat panel without frame.
 - a. Frame Finish: N/A.
 - 8. Tactile Letters: Raised 1/32 inch minimum.
 - 9. Braille: Grade II, ADA-compliant.
 - 10. One-Sided Wall Mounting: Tape adhesive.

2.03 SIGNAGE APPLICATIONS

A. Room and Door Signs:

END OF SECTION

SECTION 10 4413 FIRE PROTECTION CABINETS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
- B. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- C. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.
- B. Related Requirements:
 - 1. Section 10 4416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
 - 2. Show location of knockouts for hose valves.
- B. Shop Drawings: For fire-protection cabinets.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.05 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.03 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
 - a. J. L. Industries, Inc.; Activar Construction Products Group, Inc.

- b. Larsen's Manufacturing Company.
 - c. Nystrom, Inc.
- B. Cabinet Construction: Nonrated and One-hour fire-rated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet.
- D. Fully-Recessed Cabinet: One-piece combination trim and perimeter door frame flush with surrounding wall surface.
- E. Cabinet Trim Material: Clear anodized aluminum, 18 gauge.
- F. Door Material: Clear anodized aluminum, 18 gauge.
- G. Door Style: Vertical duo.
- H. Door Glazing: Tempered float glass (clear) .
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting door pull and friction latch .
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words " FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Decals.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
- K. Materials:
 - 1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Factory primed for field painting .
 - 2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 0.12 inch thick, Class 1 (clear) .

2.04 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Miter corners and grind smooth.
 - 3. Provide factory-drilled mounting holes.
 - 4. Prepare doors and frames to receive locks.
 - 5. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 - 2. Fabricate door frames of one-piece construction with edges flanged.
 - 3. Miter and weld perimeter door frames and grind smooth.

- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.05 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. 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.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Provide inside latch and lock for break-glass panels.
 - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification:
 - 1. Apply decals at locations indicated.
 - 2. Apply decals on field-painted fire-protection cabinets after painting is complete.

3.04 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 11 5000 LABORATORY EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The laboratory equipment suppliers are to comply with the requirements of this section for laboratory equipment and related components and accessories for "Laboratory Equipment". This Section includes reference to the following items indicated herein or in the construction documents:
 - 1. Provide everything necessary for, and incidental to, the complete installation of laboratory equipment as specified herein. Items included are:
 - a. Laminar Flow Cabinet
 - b. Biological Safety Cabinet (Class II B2)
 - c. Sterilizer
 - d. Glassware Washer
 - e. Ice Machine
 - f. Ventilated Gas Cylinder Cabinet
 - g. Spill Kit
 - 2. Furnish and install laboratory equipment as indicated on the drawings and specified herein to be Contractor Furnished, Contractor Installed (CFCI), unless otherwise specified.
 - 3. For all pieces of equipment that require water feed, follow manufacturers' recommendations to optimize equipment performance, reduce maintenance and promote water conservation.
- B. Related Requirements:
 - 1. Section 06 1053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring laboratory equipment.
 - 2. Section 09 2216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory equipment.
 - 3. Section 22 4000 "Plumbing Fixtures" for faucets and connections.
 - 4. Section 26 0000 for electrical connections

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory equipment.
- B. Coordinate installation of laboratory equipment with installation of fume hoods and other laboratory equipment.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Indicate locations of blocking and other supports required for laboratory equipment, where it corresponds.
 - 2. Indicate locations and types of services, together with associated service requirements and supply connections.
 - 3. Show adjacent walls, doors, windows, other building components, laboratory casework, fume hoods, environmental rooms and other laboratory equipment. Indicate clearances from above items.
 - 4. Include coordinated dimensions with laboratory casework specified in other Sections.

- B. Shop Drawings: Submit shop drawing that show, in large scale, methods of construction, joining, dimensions, materials, thicknesses, and finish of materials, installation, and relation to adjoining work, and all other details to fully illustrate the scope of work.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Test Reports for Equipment: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory equipment with requirements of specified product standard and system structural performance specified in "Performance Requirements" Article.

1.07 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Manufacturers shall have an established organization and production facilities specializing in producing the type of equipment specified, with an experienced engineering department. Each shall have the demonstrated ability and capacity to produce and deliver the specified equipment within the required time limits.
- B. Any deviations from the Drawings or Specifications, including requests for approval of proposed equals, must be listed in detail. List of deviations shall be submitted along with the Bidder's proposal.
- C. Installer Qualifications:
 - 1. Experience: Installer is to have a minimum of seven (7) years of experience installing laboratory equipment and who has completed a minimum of ten (10) successful installations of products as specified which are similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance within the past five years.
 - 2. Supervisor/foreman: Maintain a full-time supervisor/foreman on job site during times that laboratory equipment installation is in progress, who has a minimum of five (5) years of experience with the installation of laboratory equipment systems of which three (3) years as a full-time foreman.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.
- B. Deliver laboratory equipment after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate equipment has been completed in installation areas. If equipment must be stored in non-installation areas, store only where environmental conditions meet requirements specified in Project Conditions section below.
- C. Protect finished surfaces of room and of equipment from soiling and damage during handling and installation.

1.09 FIELD CONDITIONS

- A. Locate concealed framing, blocking, and reinforcements that support equipment by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- B. Environmental Limitations: Do not deliver or install laboratory equipment until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.10 WARRANTY

- A. All equipment furnished under this section shall be guaranteed with the maximum industry warranty against defective materials, design and workmanship—warranty shall be made to the benefit of the owner.
 - 1. MAINTENANCE

- B. Furnish maintenance and call back service for a period of 60 months for each type of laboratory equipment after completion of installation or acceptance thereof by beneficial use, whichever is earlier, during normal working hours excluding callbacks.
 - 1. Service shall consist of periodic examination of the equipment, adjustment, lubrication, cleaning, and parts to keep the equipment in proper operation. Maintenance work, including emergency call back repair service, shall be performed by employees trained or certified by the laboratory equipment manufacturer, during regular working hours.

PART 2 PRODUCTS

2.01 EQUIPMENT ITEMS – GENERAL REQUIREMENTS

- A. Furnish and install equipment as indicated and identified on the drawings by the manufacturers and in the models, sizes and with the qualities shown. Provide each with the manufacturer's standard features and accessories as well as any other accessories, options or special configurations shown on the drawings or elsewhere in the specifications. For recessed or freestanding equipment, provide trim panels to close opening between equipment and adjacent walls, floors and ceilings.
- B. Refer to "Laboratory Equipment Schedule," Drawing Sheet A810, for additional information on building supplied services and special requirements. Building services are being provided to support the Basis of Design models indicated. Alternate manufacturers must work properly with the utility services provided. Any changes required to the infrastructure to support alternative equipment will be the responsibility of the Contractor, including but not limited to redesign of utility infrastructure.

2.02 LAMINAR FLOW ENCLOSURE

- A. Description: Console enclosure, with base stand, providing biological containment protection for both operator and product. Cabinet will be provided with 99.99 efficient HEPA filtration on supply and exhaust.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Labconco Nexus Horizontal Clen Bench (Catalog 5341600), or comparable product by one of the following:
 - a. Baker
 - b. Esco Technologies
 - c. NuAire
 - 2. Construction
 - a. Size: 4', nominal, 26" interior depth
 - b. Interior Liner shall be Type 304 Stainless Steel with glass side panels
 - c. Provide with base stand
 - 3. Air Flow
 - a. Nominal Face Velocity: 85 fpm
 - b. Blower with Electronically Commutated Motor (ECM) shall be programmed to deliver a precise volume of air as required and automatically adjusts as filters load without relying on airflow sensors and protected from voltage (electrical) fluctuation.
 - 4. Features
 - a. Operating System Features:
 - 1) Full color touch screen display
 - 2) Full operational, maintenance and certification logs for detailed record keeping
 - 3) Numeric and visual HEPA filter life graphics.
 - 4) Status line for alarm conditions and alerts to warn when filter life diminishes to 20% and 10% before alarming at 0%.

2.03 BIOLOGICAL SAFETY CABINETS

- A. Description: Console enclosure, with telescoping base stand, providing biological containment protection for both operator and product. Cabinet will be provided with 99.99 efficient HEPA filtration on supply and exhaust.
 - 1. NSF/ANSI 49 Classification: Class II, Type B2 Laminar Airflow - Ducted.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Labconco, Purifier Logic+ (catalog 303480001), or comparable product by one of the following:
 - 1. Baker
 - 2. Esco Technologies
 - 3. NuAire
- C. Construction

1. Size: 6', nominal typical. Refer to drawings for sizing.
 2. Interior Liner shall be 16 gauge, Type 304 Stainless Steel. Work surface shall be 18 gauge, or greater, type 304 stainless steel.
- D. Air Flow
1. Air Velocity: 100 to 110 fpm through 10" sash opening, with audible alarms which sounds when sash is not at its proper operating height.
 2. Downflow Velocity: 50 to 60 fpm measured 4" above operating sash opening height. Must be true laminar (uniform) downflow as defined in NSF/ANSI Standard 49.
 3. Blower with Electronically Commutated Motor (ECM) shall be programmed to deliver a precise volume of air as required and automatically adjusts as filters load without relying on airflow sensors and protected from voltage (electrical) fluctuation.
- E. Features
1. Microprocessor Control System, with accessible mounted controls for blower, light, electrical outlets, timers, alarm mute, and menu navigation.

2.04 GLASSWARE WASHER UNDERCOUNTER

- A. Description: High Performance electric laboratory glassware washer. Free-standing without view window
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Steris Reliance 100 Series, or comparable product by one of the following:
1. Miele Professional
 2. Steris
 3. Or approved equal, if specifically approved by Architect via addendum during bidding.

2.05 SMALL STERILIZER/FRONT LOAD AUTOCLAVE

- A. Description: Laboratory Steam Sterilizer is designed for fast and efficient sterilization of heat- and moisture- stable materials used in scientific applications.
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Steris Amsco, Model 250LS, or comparable product by one of the following:
1. BMT USA
 2. Beta Star Life Science Equipment, Inc.
 3. Consolidated
 4. Lancer
 5. Primus
 6. SteelCo
 7. Tuttnauer
 8. Or approved equal, if specifically approved by Architect via addendum during bidding.
- C. Construction
1. Freestanding with enclosure cabinet.
 2. Integrated electric steam generator (stainless steel).
 3. Chamber Size: 20" W x 20" H x 38" D, Gravity.
- D. Accessories
1. Provide with loading rack and two shelves.

2.06 ICE MACHINE

- A. Description: Flake type ice machine capable of producing 398 lbs per day
- B. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Manitowac, UFP0350A, or comparable product by one of the following:
1. Hoshizaki
 2. Scotsman

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF EQUIPMENT

- A. Uncrate all equipment and place in locations shown. Remove all crating materials and packing debris.
- B. Install all items in accordance with manufacturer's instructions. Provide all accessories necessary for a complete installation.
- C. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer's specifications and options for Contractor-furnished items and with Owner for Owner-furnished items and coordinate connections with Division-22, 23 and 26 work.
- D. Furnish instruction manuals for all Contractor-furnished equipment to the Owner.

3.03 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain laboratory equipment.

3.04 CLEANING AND PROTECTING

- A. Repair or remove and replace defective work as directed upon completion of installation.
- B. Clean shop-finished surfaces, touch-up as required, and remove or refinish damaged or soiled areas, as acceptable to Architect.
- C. Protection: Advise Contractor of procedures and precautions for protection of equipment from damage by work of other trades.

END OF SECTION

**SECTION 12 3553
METAL LABORATORY CASEWORK**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. BHMA A156.9 - Cabinet Hardware; 2020.
- B. BHMA A156.11 - American National Standard for Cabinet Locks; 2019.
- C. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- D. NFPA 30 - Flammable and Combustible Liquids Code; 2024.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. SEFA 2.3 - Installations; 2010.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fixed Metal laboratory casework.
 - 2. Fixed stainless-steel casework
 - 3. Movable metal laboratory casework
 - 4. Filler and closure panels.
 - 5. Laboratory casework system that includes support and utility-space framing, filler and closure panels, wall panels, and modular countertops.
 - 6. Laboratory countertops.
 - 7. Tables.
 - 8. Shelves.
 - 9. Laboratory accessories.
- B. Related Requirements:
 - 1. Section 06 1053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring laboratory casework.
 - 2. Section 09 2216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework.
 - 3. Section 09 6513 "Resilient Base and Accessories" for resilient base applied to metal laboratory casework.
 - 4. Section 11 5313 "Laboratory Fume Hoods" for fume hoods, including base cabinets and countertops under fume hoods.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.
- B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, and attachment details.
 - 1. Indicate types and sizes of cabinets.
 - 2. Indicate locations of hardware and keying of locks.
 - 3. Indicate locations and types of service fittings.

4. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 5. Include details of support framing system.
 6. Include details of exposed conduits, if required, for service fittings.
 7. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
 8. Include coordinated dimensions for laboratory equipment specified in other Sections.
- 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 Verification: For each type of cabinet finish and each type of countertop material, in manufacturer's standard sizes.
- E. Samples for Verification: Unless otherwise directed, approved full-size Samples may become part of the completed Work, if in an undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations. If acceptable full-size Samples at Project site are not incorporated into the Work, retain and remove them when directed by Architect.
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. One Sample each of hinged and sliding doors.
 4. 6-inch-square Samples for each type of countertop material.
 5. One of each service fitting specified, complete with accessories and specified finish.
 6. One of each type of hardware item specified.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish complete touchup kit for each type and color of metal laboratory casework provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 M.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fixed Metal Laboratory Casework:
1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Mott Manufacturing, or comparable product by one of the following:

- a. AT Villa, Inc.
 - b. Bedco Lab
 - c. Kewaunee
 - d. Hanson Lab Solutions
- B. Movable Metal Laboratory Casework:
 1. [Basis-of-Design Product](#): Subject to compliance with requirements, provide Mott Manufacturing, Altus Table System or comparable product by one of the following:
 - a. AT Villa, Inc.
 - b. Bedco Lab
 - c. Kewaunee
 - d. Hanson Lab Solutions
- C. Product Designations: Drawings indicate sizes, types, and configurations of fume hoods by referencing designated manufacturer's catalog numbers. Other manufacturers' fume hoods of similar sizes, types, and configurations, and complying with the Specifications, may be considered. See Section 01 6000 "Product Requirements."
- D. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
- E. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with Specifications may be considered. See Section 01 6000 "Product Requirements."

2.02 PERFORMANCE REQUIREMENTS

- A. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:
 1. Support Framing System: 600 lb/ft..
 2. Suspended Base Cabinets (Internal Load): 160 lb/ft..
 3. Work Surfaces (Including Tops of Suspended Base Cabinets): 160 lb/ft..
 4. Wall Cabinets (Upper Cabinets): 160 lb/ft..
 5. Shelves: 40 lb/sq. ft..

2.03 CASEWORK, GENERAL

- A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."
- B. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction.
- 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.

2.04 METAL CABINET AND TABLE MATERIALS

- A. Metal: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

2.05 AUXILIARY CABINET MATERIALS

- A. Acid Storage-Cabinet Lining: 1/4-inch-thick, polyethylene, polypropylene, epoxy, or phenolic-composite lining material.
- B. Tempered Glass for Glazed Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 0.2 inch thick.

2.06 COUNTERTOP TABLETOP AND SHELF MATERIALS

- A. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.
 1. Physical Properties:

- a. Flexural Strength: Not less than 10,000 psi.
 - b. Modulus of Elasticity: Not less than 2,000,000 psi.
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 degrees Fahrenheit.
2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
3. Color: Black

2.07 METAL CABINETS AND TABLES

- A. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt- and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.
- B. Design of Metal Doors and Drawer Fronts: Flush Inlay with square edges.
- C. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.
- D. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal.
- E. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.
- F. Toe Space: Fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.
- G. Tables: Welded tubing legs, not less than 2 inches square with channel stretchers as needed to comply with product standard. Weld or bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device welded to bottom of each leg.
 1. Leg Shoes: Satin-finished, stainless-steel, open-bottom, slip-on type.
- H. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges unless otherwise indicated.
 1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where. Fabricate from back-to-back panels or of hollow construction to eliminate exposed hemmed or flanged edges.
 2. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.08 MOVEABLE LABORATORY CASEWORK SYSTEM

- A. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular cabinets, filler and closure panels, wall panels, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.
 1. Cabinet Construction: Metal
 2. Base cabinets can be removed without providing temporary support for, or removing, countertops.
 3. Support framing has provision for fastening pipe supports at utility space in not more than 1-inch increments.

4. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate panels from same material and with same finish as metal cabinets and with hemmed or flanged edges.
5. Mobile Base Cabinets Construction to match fixed casework.
 - a. Provide with locking casters
 - b. Provide Epoxy Resin Work Surface for mobile base cabinets.
- B. Support Framing: Casework manufacturer's standard system consisting of vertical supports and connecting braces and rails as follows:
 1. Cabinets, shelves, and countertops are supported from vertical supports except where floor-supported base cabinets are indicated. Vertical positioning of supported cabinets, shelves, and countertops can be varied in 1-inch increments through full height of supports.
- C. Countertops: Provide in modular lengths indicated, without seams.

2.09 METAL CABINET FINISH

- A. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.
- B. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- C. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 M. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.
 2. Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.

2.10 HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
 1. Finishes
 - a. Stainless Steel
 - b. 32D to match door hardware
- B. Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches high or less and three for doors more than 48 inches high.
- C. Hinged Door and Drawer Pulls: Solid-aluminum, stainless-steel, or chrome-plated-brass, back-mounted pulls. Provide two pulls for drawers more than 24 inches wide.
 1. Design: Wire pulls.
 2. Overall Size: 1-1/4 by 4-1/2 inches.
- D. Door Catches: Nylon-roller spring catches. Provide two catches on doors more than 48 inches high.
- E. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
 1. Provide Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
 2. Provide Grade 1HD-200; for drawers more than 6 inches high or 24 inches wide.
 3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-extension, ball-bearing type.

- F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide where indicated.
- G. Locks: Cam or half-mortise type with five-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281, Type E07111, or Type E07021.
 - 1. Provide a minimum of two keys per lock and two master keys.
 - 2. Provide where indicated.
 - 3. Keying: Keylocks as directed.
 - 4. Master Key System: Key all locks to be operable by master key.

2.11 COUNTERTOPS, TABLETOPS, SHELVES AND SINKS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch, with continuous drip groove on underside 1/2 inch from edge.
- B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - 1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2, unless otherwise indicated.
 - 2. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches less than sink depth. Provide in same material as strainer.
- C. Epoxy Countertops, Sinks and Tabletops:
 - 1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.
 - a. Countertop Configuration: Flat, 5/8 inch thick, with beveled edge and corners, and with drip groove and applied backsplash.
 - 2. Tabletop Fabrication:
 - a. Tabletop Configuration: Flat, 5/8 inch thick, with beveled edge and corners, and with drip groove at perimeter.
 - 3. Sink Fabrication: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch minimum thickness.
 - a. Sink Configuration:
 - 1) 25"x15"x10"D
 - 2) 25"x15"x4.8"D (Accessible)
 - b. Provide with polypropylene strainers and tailpieces.
 - c. Provide sinks for drop-in installation in epoxy countertops with 1/4-inch-thick lip around perimeter of sink.
- D. Stainless Steel Scullery Sinks
 - 1. Sink Fabrication – 16 Gauge – 300 Series Stainless Steel Single Scullery sink with right drainage boards with #4 finish. Basis-of-Design Manufacturer ELKAY Dependabilt 50-1/2" x 29-13/16" x 43-3/4"

2.12 CEILING LINEAR SERVICE PANEL (LSP)

- A. 10-inch wide ceiling service linear panel, 14 gauge cold rolled steel with a powder coated finish.
 - 1. Color: White
- B. Provide Altus System Ceiling Service Panel in custom sizes and configurations as indicated, by Mott Manufacturing. Provide linear panel pre-plumbed and pre-wired for utilities indicated. Refer to drawings for location and configuration of utilities and connections.
 - 1. Provide quick-disconnect for all plumbed services
 - 2. Provide Twist-lock receptacles for all electrical services.
 - 3. Provide Cat6A receptacles for all data connections

2.13 LABORATORY ACCESSORIES

- A. Pegboards: Stainless Steel pegboards with removable polypropylene pegs and stainless-steel drip troughs with drain outlet.
 - 1. Size: 30"Hx24"W
- B. Cylinder Restraints: Wall mounted, powder coated steel with polypropylene support straps capable of restraining two gas cylinders. Basis-of-Design: USA Safety Model GB200FS

2.14 WATER AND LABORATORY GAS SERVICE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. [WaterSaver Faucet Co.](#)
 - a. Recessed Safety Station with Drain Pan, Exposed Shower Head: Recessed barrier-free eye/face wash and shower with pull down opening cover and automatic activation
 - 1) Water Saver, Model SSBF2152 (Locations with Ceiling)
 - b. Recessed Safety Station with Drain Pan, Exposed Shower Head: Recessed barrier-free eye/face wash and shower with pull down opening cover and automatic activation, for fire-rated construction.
 - 1) Water Saver, Model SSBF2352 (Fire-Rated Walls)
 - c. Recessed Safety Station with Drain Pan, Exposed Shower Head: Recessed barrier-free eye/face wash and shower with pull down opening cover and automatic activation
 - 1) Water Saver, Model SSBF2172 (Locations that are open to structure)
 - d. Barrier Free Eyewash Autoflow 90 degree Swing Deck Mount:
 - 1) Water Saver, EWBF849 - Provide control handing as indicated on drawings
 - e. Deck Mounted Laboratory Mixing Faucet with Wrist Blade Handles:
 - 1) Water Saver, Model L414VB-BH
 - f. Deck Mounted Laboratory Pure Water Faucet with Self Closing Lever Handle:
 - 1) Water Saver, Model L7853SC-LE - - Provide control handing as indicated on drawings.
 - g. Wall Mounted Laboratory Ball Valve with Removable Serrated End:
 - 1) Water Saver, Model L4200-158FT
 - h. Panel Mounted Laboratory Ball Valve with Removable Serrated End:
 - 1) Water Saver, Model L4200-158WSA
 - i. Panel Mounted Quick Connect Bodies for use with flexible casework. Coordinate locations with drawings. Provide standard color coding for utilities provides
 - 1) Water Saver QCFL Series
 - j. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.
 - k. Deck Mounted Laboratory Ball Valve (Twin Turret) with Removable Serrated End:
 - 1) Water Saver, Model L4200-132SWSA
- B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.
- C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.
 - 1. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.
 - 2. Finish: Chromium plated.
- D. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

2.15 ELECTRICAL AND DATA SERVICE FITTINGS

- A. Electrical Fittings: Electrical fittings shall contain 20 Amp., 125 Volt AC, 3-wire polarized grounded receptacles, unless otherwise specified. Receptacle boxes shall be of plated steel. All electrical or conduit fittings called for or to be furnished under these specifications shall meet the requirements of the National Electrical Code. Provide with twist lock plug and extension cord for connection to overhead linear service panel.
- B. Data Fittings: Provide Cat 6A receptacle. Provide male plug with adequate extension to connection to overhead linear service panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
 - 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 - 2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet.
 - 3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
 - 4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 - 5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than 16 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
 - 1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than two fasteners per side.
- D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches o.c.
- E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.03 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where indicated on Shop Drawings.
- B. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.
 - 1. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.
- C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
 2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
 3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch, and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- D. Provide required holes and cutouts for service fittings.
- E. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework.
- F. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.04 INSTALLATION OF LABORATORY ACCESSORIES

- A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.
- D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.05 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-milplastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

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SECTION 12 3661 QUARTZ COUNTERTOPS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- B. PS 1 - Structural Plywood; 2023.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Quartz sill at glazed aluminum storefront system.

1.04 ACTION SUBMITTALS

- A. Product Data: For quartz material.
- B. Samples for Initial Selection: All quartz materials specified in Interior Finish Schedule.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.06 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 PRODUCTS

2.01 QUARTZ -MATERIAL COUNTERTOPS SS-1

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
 - 1. SS-1 Wilsonart 9208CS White Stone
 - a. 1/2-inch thickness
 - b. Provide Eased edge
- B. Configuration: Provide countertops with the following front and backsplash style:
 - 1. Sill: As indicated on drawings.
 - 2. Edge: 1-1/2-inch laminated eased-edge profile.
- C. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing. If tops can not be fabricated to specified sizes with single piece, alert design team prior to fabrication.
- D. Substrate: Plywood, exterior soft plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet .
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 1. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

2. Seal edges of cutouts in particleboard subtops by saturating with varnish.

END OF SECTION

SECTION 21 0553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.03 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.

1.04 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

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.
 - 3. Seton Identification Products.

2.02 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: Background to contrast with letter color.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 4 inches wide by 1-1/2 inches high.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the 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 Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.03 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. 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.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.04 STENCILS FOR PIPING

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
1. Stencil Material: Brass.
 2. Paint: Standardized colors for the entire piping system shall be painted per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

SYSTEM	COLOR
Fire-Suppression	Red

3. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

BAND AND LETTER SIZE ALL DIMENSIONS IN INCHES

Outside Diameter of Pipe Covering	Width of Color Band	Size of Letters and Numerals
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

4. Pipe Identification: Identify pipe at wall penetrations, machine or tank connections, and at not over 20 foot intervals. Marker identification should be visible from the floor. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

SERVICE	MARK
Fire	Fire

2.05 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2-inch numbers.
- Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
- Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
- Size: 3 inches by 5-1/4 inches minimum.
 - Fasteners: Brass grommet and wire.
 - Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Equipment to be identified with plastic nameplates includes but is not limited to sprinkler alarm valve assemblies, backflow preventers, etc.
- B. Identify valves with tags.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of equipment.

- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections – All pipe identification shall be stenciled legibly on pipe.
- 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.

3.05 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.
- B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner's Representative.

3.06 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

UNIVERSITY OF NORTH TEXAS

SECTION 211100
FACILITY FIRE SUPPRESSION WATER-SERVICE PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and other Division 1 Specification Sections, apply to this Section

1.2 SUMMARY

- A. This section addresses underground fire-suppression water-service piping (fire mains) and its related components extending from the connection to the public water utility supply tap and extending into the building, as indicated on the approved design drawings.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's specifications for each type of product to be used on project.
- B. Shop Drawings and details indicating locations and depths of underground main and FDC piping; size of pipe, fittings and valves; type of pipe and fittings materials; size, type and location of pressure blocking; type of backfill material(s); type(s) of underground risers; location and type of vaults, backflow devices, flow meters, and yard valves.
- C. Copies of the contracting firm's Texas Department of Insurance (TDI) Sprinkler Contractor Registration – General (SCR-G), Responsible Managing Employee - General (RME-G), Responsible Managing employee Underground (RME-U) and the required Texas Department of Insurance's Liability Insurance Certificate, signed by a Texas Insurance Agent.

1.4 QUALITY ASSURANCE

- A. The contracting firm installing the underground fire main shall specialize in the design and installation of underground fire mains. The firm shall have a minimum of three years of verifiable design and installation experience in underground fire mains.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. The Contractor shall protect all piping materials from contamination during storage, handling and installation. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped or at the close of the day's work.
- D. Regulatory requirements:
 - 1. Comply with all requirements of the public water purveyor's, TCEQ and UNT's requirements for connecting to the public utility water main.
 - 2. Comply with NFPA 24 and direction of UNT for materials, installation, tests, flushing, chlorination, valve and associated appurtenances for fire suppression water service piping.
 - 3. Comply with the "Approval Guide," published by FM Global, or UL's "Fire Protection Equipment Directory" for fire-service main products.
- E. Minimum Required Inspections:
 - 1. Visual inspection of the installation shall be performed **PRIOR TO** covering any of the pipe, joints, fittings, valves, ductile iron, thrust blocks, restraints or other metal parts. Where any part is so covered prior to the visual inspection, the contractor will be required to uncover the part(s) for visual inspection at no cost to Owner.
 - 2. Pipe labeling must be turned upward and visible.
 - 3. Depth of bury of the pipe will be measured and verified.
 - 4. All angle fittings shall be pressure blocked with poured-in-place cement pressure blocks or anchored retaining straps. Pressure and gravity anchor blocks shall be appropriately sized per NFPA 24 or by a Texas Professional Engineer and bear onto undisturbed soil.
 - 5. All metal components being installed underground shall be externally coated for corrosion and poly-wrapped.

6. Hydrostatic Testing of the fire sprinkler underground main is required.
 - a. All new fire service mains shall be tested hydrostatically at not less than 200 psi pressure for a minimum of two hours, or at 50 psi pressure in excess of the maximum static pressure when the maximum required static pressure exceeds 150 psi.
 - b. A pressure loss of more than 5 psig, or leaks will result in a failed inspection.
 - c. The Hydrostatic test shall be made by the installing contractor and witnessed by the Owner's Representative.
7. Cleaning, disinfecting, flushing and biological testing:
 - a. Underground fire mains being connected to any potable water utility line must be disinfected, flushed and pass bacteriological testing prior to being connected to any potable water utility line.
 - b. Isolate fire main system from public water utility main with RPZ backflow prevention device.
 - c. Clean new piping system and parts of existing system that have been altered, extended or repaired.
 - i. Use flushing procedure described in NFPA 24 for flushing of pipe.
 - ii. Use disinfecting procedure described in AWWA C651.
 - iii. Once disinfecting test is complete and approved, re-flush the underground piping and perform bacteriological testing.
 - iv. Samples for bacteriological analysis will only be collected from suitable sampling taps and collected in sterile bottles treated with sodium thiosulfate. Samples shall not be drawn from hoses, fire hydrants or unregulated sources.
8. Flushing, disinfecting, re-flushing and bacteriological sampling of lines shall be done by the installing contractor and witnessed by the Owner's Representative.
9. Proper methods and equipment to perform the flush must be used. All piping used to flush must be properly secured or restrained. Owner's Representative must approve of flushing method and equipment.

1.4 COORDINATION

- A. Coordinate location of underground fire main with fire sprinkler contractor, UNT Utilities Supervisor and public water purveyor's requirements. Coordinate FDC location at the direction of the UNT System Fire Marshal.

PART 2 -- PRODUCTS

2.1 WATER PIPING MATERIALS

- A. Underground -- Polyvinyl Chloride (PVC) Pipe (NO EXCEPTION)
 1. American National Standard for PVC pipe 12 inches and under, AWWA Standard C900, Class 200 (DR14).
 2. Pipe greater than 12 inches shall be AWWA Standard C905, Class 200 (DR14).
 3. Color: Blue
- B. Aboveground extension to backflow prevention device
 1. Where the underground fire service pipe emerges from below grade and does not immediately terminate with a control valve and backflow prevention device (double check valve assembly) in a readily accessible location, the above-ground extension of the fire service pipe shall be galvanized steel or stainless steel pipe run to the control valve and backflow prevention device located in a readily accessible location.
- C. Valves:
 1. Gate valves, 12" and under (resilient seated): AWWA C509 Standard
 - a. General Description: Valves shall be full opening, iron body, non-rising stem, resilient seated wedge type so designed to have complete **ZERO** leakage with flow in either direction at pressures up to two hundred (200) psi. The valves shall be designed for throttling if required.
 - b. Coating: Valves shall have all internal ferrous metal surfaces coated with an approved epoxy coating to provide a corrosion resistant barrier. The epoxy coating shall be holiday free with a minimum thickness of not less than four (4) mils. The coating shall be non-toxic after application and shall impart no taste to water.
 - c. Operating stems: Valves shall have two (2) "O" ring stem seals. Valves shall have the thrust collar and bearing surfaces isolated from the waterway and be provided with continuous lubrication, or they shall be provided with non-corrosive thrust bearings above and below the thrust collar. Where the

operating nut exceeds forty eight (48) inches, in depth (below finish grade), a permanently attached extension shall be attached to the valve stem to bring it to the minimum depth of forty-eight (48) inches. All valves shall open by turning to the left and shall have a two-(2) inch operating nut or be hand-wheel operated as shown on the plans.

d. Approved Manufacturers:

- i. Mueller
- ii. Waterous
- iii. Kennedy
- iv. American-Darling
- v. Clow Corporation
- vi. J&S Valves

D. Fittings:

1. Mechanical Joint: ANSI/AWWA-C110/A21.10 or ANSI/AWWAC153/A21.53 Standards
2. Flange Joint: ANSI/AWWA-C111/A21.11 or ANSI/AWWA-C153/A21.53 Standards
3. Push-on Joint: ANSI/AWWA-C111-A21.10 or ANSI/AWWA-C153/A21.53 Standards
4. Fittings: Ductile Iron ANSI/AWWA-C153/A21.53; Cast Iron ANSI/AWWAC110/A21.10 and ANSI/AWWA-C111/A21.11 Standards.
5. Bends: ASTM D-3139. Megalug™ retaining glands or equal shall be used on all bends, tees and plugs
6. Gaskets: ASTM F477 Standards
7. Bolts, Bolt-studs and "T" Head Bolts:
 - a. Length: Shall be such that the ends project ¼ to ½ inch beyond surface of nuts.
 - b. Ends: Chamfer or rounded.
 - c. Threading: ANSI B1.1 coarse thread series, class 2A Fit. Bolt-studs may be threaded full length. Studs for tapped holes shall be threaded to match threading in holes.
 - d. All bolts, bolt-studs and "T" head bolts (ANSI/AWWA C111/A21.11-80) shall be either:
 - i. A242 high strength low alloy steel with enhanced atmospheric corrosion resistance (ASTM A325 Type III); or
 - ii. Stainless Steel Grade 304 or 316 high strength bolts
 - e. All nuts are to be A563 carbon alloy steel; Grade and finish to be C3.

Exception: All-thread rod to be used in thrust harness only, shall be high strength, corrosion-resistant alloy (ASTM A325 Type II) with hexagonal nuts. Where all-thread rods, nuts and washer are used, they are to be painted with "ROYSTON ROSKOTE MASTIC R28" Rubberized mastic as manufactured by ROYSTON LABORATORIES, INC. of Pittsburgh, Pennsylvania or equivalent.

PART 3 - REACTION RESTRAINTS AND THRUST-BLOCKING

3.1 Restraints and thrust blocking for all piping with mechanical coupling, push-on or mechanical joints, or similar joints subject to internal pressure shall be thrust-blocked or restrained per NFPA 13 for Underground Piping to prevent separation of the joints.

1. Thrust-blocking shall be designed (placement, size, cement mix) by the RME or a Texas Registered Professional Engineer and shown on the installation plans.

PART 4 - EXCAVATION

4.1 Excavation: Excavation in general, shall be made in open cut from the surface of the ground and shall be no greater in width and depth than is necessary to permit the proper construction of the work.

- A. Excavating and trenching shall be performed in accordance with State of Texas Law and OSHA requirements.
 1. Underground utilities in the area(s) being excavated shall be located, identified and marked by utility operator. Call TEXAS811 (dial 811), 48 hours in advance of the excavation and request line locates.
- B. The amount of trench excavation to grade shall not exceed 100 (one hundred) feet from the end of the pipe laying operations and no excavation shall be 300 (three hundred) feet in advance of the completed pipe operations (includes backfilling). At the end of the workday, all trench excavation shall be backfilled or surrounded with substantial chain-link fencing at least 6 (six) feet in height, attached to steel poles that are firmly anchored into the ground. Any landscaping, irrigation system, paving or utility that is disturbed, removed,

or damaged during construction shall be replaced to original condition or better by the contractor.

- C. Minimum bury depth: Minimum bury depth shall be forty-eight (48) inches from finished grade to the top of the pipe or as directed by the Owner.
- D. Backfill Compaction:
 - 1. Mechanical Method: Compaction and consolidation of the backfill materials shall be backfilled using the native material free of tree roots, large rocks and other deleterious materials, and compacted to 95 percent of maximum density as determined by ASTM D698 in six (6) inch lifts at optimum moisture content (to plus 4 percent above optimum moisture content) in areas subject to vehicular traffic, within 5 feet of and inside building footprints and other paved areas, and in ten (10) inch lifts in any other areas not specified. Where subject to vehicular traffic, within 5 feet of or inside the building footprint and other paved areas, density tests shall be performed at the rate of one test per 300 LF per one foot of trench depth.
 - 2. Water Jetting Method: Water jetting is not allowed.

END OF SECTION

UNIVERSITY OF NORTH TEXAS
SECTION 211313
FIRE PROTECTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes labor and materials for the installation of a hydraulically calculated automatic, sprinkler system(s), complete in all respects and ready for operation.
 - 1. Work includes the design of a hydraulically calculated, wet-pipe, automatic sprinkler system, designed for 100% coverage of the building.
 - 2. In areas where ambient temperature cannot be maintained at 40° or above, a dry pipe sprinkler system or a monitored heat tape system shall be provided.
 - 3. Design and installation of the sprinkler system shall be such that no parts interfere with general construction, doors, windows, heating, plumbing, air conditioning systems or electrical equipment.
- B. System components for each zone shall include, but not be limited to:
 - 1. Zone control valve and test/drain assembly.
 - 2. Drain valve.
 - 3. Waterflow switches.
 - 4. Valve supervisory switches.
 - 5. Piping.
 - 6. Sprinkler heads.

1.2 SYSTEM DESCRIPTION

- A. The sprinkler system shall be an automatic fire sprinkler system supplied by a pressurized water supply (Municipal water main) to fusible sprinkler heads for the control of fire.
- B. The sprinkler system shall be hydraulically designed to meet the more stringent of the requirements of the 2019 Edition of NFPA 13.
- C. Work shall be installed in accordance with NFPA 13 and Owner's direction. Devices and equipment shall be listed by Underwriters' Laboratories, Inc. or Factory Mutual-approved, individually and as a system, as applicable.
- D. Coordinate the location of sprinkler heads and piping such that it does not interfere with the installed ceiling configuration or other building construction and equipment.

1.3 HYDRAULIC CALCULATIONS

- A. Prepare hydraulic calculations in accordance with NFPA 13 and with the following exceptions:
 - 1. Provide a minimum safety factor of 10 psi on all hydraulically calculated sprinkler systems.
- B. Hydraulic calculations shall be performed by a State of Texas Licensed Responsible Managing Employee (RME) in the direct employ of the fire protection contractor, or by a Texas State Registered Professional Engineer (P.E.).
- C. A recent fire flow test shall be the basis for the fire sprinkler design.

1.4 SUBMITTALS

- A. Contractor's Qualification Data: Copies of fire sprinkler firm's TDI registration, RME License and Liability Insurance.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Submit 3 (three) full-size sets of shop drawings for review. Plans must include the following:
 - 1. A "Wet" RME or Texas Professional Engineer's signature and stamp, is required on all plan drawings and calculations.
 - 2. Plans shall be clear and legible and all sheets shall be in a common and appropriate scale;
 - 3. The following information shall be provided on the plans:
 - a. Site plan showing location of the building, all fire hydrants, fire lanes, fire department connections and the fire service main location.
 - b. Scale.

- c. Floor plan.
 - d. Square footage.
 - e. Location of doors.
 - f. Intended use of each room is identified.
 - g. North arrow provided.
 - h. Location of the Fire Department Connection (FDC).
 - i. Occupancy classification.
 - j. Scope of Work.
 - k. Equipment List.
 - l. Hydraulic calculations for each design area.
 - m. A complete full-height cross section of the building.
 - n. Area of coverage of each sprinkler head.
 - o. Total area protected by each system.
 - p. Capacity of the dry system or antifreeze system.
 - q. Hydraulic node symbols and schedule.
 - r. Indicate all Riser Nipples (RN) or Drop Nipples (DN).
 - s. Elevations of sprinkler lines and node points.
 - t. Hanger details.
 - u. Hanger locations.
 - v. Sprinkler riser diagram.
 - w. Inspectors test connection detail.
 - x. Auxiliary drain details.
 - y. Size and location of standpipe hose stations, if applicable.
 - z. Description of the design area.
 - aa. Design density of each design area.
 - bb. Clearly indicate each remote area.
 - cc. Provide graphic representation of the waterflow analysis.
 - dd. Provide the water supply test information.
 - ee. Provide notes to indicate the following;
 - ff. Design code.
 - gg. Responsible party with regards to freeze protection. If to be provided by others, indicate and provide drawings to indicate the heaters with your submittal.
4. The title block shall contain the following;
- a. Location of the installation.
 - b. Name and complete address of the business.
 - c. Name and complete address of the installing company.
 - d. Licensing information.
 - e. Date.
 - f. Drawn by.
5. A legend shall be provided to include:
- a. Symbol, sprinkler description, manufacturer, model number, and quantity for each device.
 - b. Pipe and fittings type.
- D. Submit 3 (three) copies of equipment specification booklets containing all materials, equipment and products that are being provided for installation.
- 1. Materials, equipment and products being used shall be identified in the specification booklets by an arrow or highlighter.
- E. Field test reports and certifications for compliance with performance requirements shall be submitted to the owner. Include "Contractor's Material and Test Certificate for Aboveground Piping"
- F. All fire system submittals shall be provided to the UNT Fire Marshal for review and approval prior to any work.
- G. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction including hydraulic calculations
- H. Welding certificates.
- I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13, Include "Contractor's Material and Test Certificate for

Aboveground Piping."

- J. Field quality-control reports.
- K. Operation and maintenance data.
- L. Submit complete "As-Built" set of plans for each fire sprinkler and standpipe system.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Specialist Firm -- The installing contractor shall specialize in the design and installation of fire sprinkler systems and shall be registered as a fire sprinkler contractor by the Texas State Board of Insurance Underwriters (TDI) and shall have in its employ, a Responsible Managing Employee (RME), licensed by the Texas State Board of Insurance Underwriters (TDI). The contractor shall have a minimum of three years of verifiable installation experience with fire sprinkler systems.
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services where needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test performed within past 90 days or less of design.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with 2013 Edition of NFPA 13.

1.6 PIPING AND FITTINGS

- A. Piping and fittings:
 - 1. All exposed, aboveground piping shall be minimum schedule 40 steel pipe*, no exception, conforming to ASTM A53 or ASTM A795, Type E, Grade A. Comply with applicable governing regulations and industry standards.
 - 2. Piping and fittings for the fire main installed between the City's water utility connection and the required backflow prevention device for the fire riser shall be ASTM approved materials for potable water systems.
 - 3. The piping system for a dry pipe system shall be schedule 40 galvanized steel.
- B. *Pipe and fittings shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.
- C. Threaded Fittings: Class 150 malleable iron, ANSI B16.3, for pipe sizes 2-inch and less.
- D. Malleable Iron Threaded Unions: ANSI B16.3, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
- E. Threaded Pipe Plugs: ANSI B16.14.
- F. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections. Fittings same thickness as pipe.
- G. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
- H. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
- I. Flanged Fittings: Comply with ANSI B16.5 for bolt-hole dimensioning, materials, and flange thickness.
- J. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
- K. Flange Bolt Thread Lubricant: Lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
- L. Saddle tap fitting are not allowed.

1.7 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section 11, Part C, for welding materials.
 - 1. Brazing Materials: American Welding Society, AWS A5.B, Classification B Cup-5.

- B. Gaskets for Flanged Joints: 1/16 inch thick for pipe size 10 inches and smaller and 1/8 inch thick for all pipe size 12 inches and larger. Ringtype shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed non-asbestos or equal.
- C. Dielectric Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation.
- D. Mechanical couplings may only be used for pipe sizes over 2-inch, to engage and lock grooved or pipe ends and to allow for some angular deflection, contraction and expansion.
 - 1. Couplings shall be positive lock type and shall consist of ASTM A536 ductile iron housing, c-shaped composition sealing gasket and carbon steel bolts conforming to ASTM A183.
 - 2. Gasket Material for wet systems shall be EPDM.
 - 3. Gasket material for dry pipe systems shall be silicone.
 - 4. All couplings shall be UL listed and approved.
 - 5. Provide only full flow (no-fabricated) fittings. Snap joint couplings, outlet couplings, cut-in style couplings, reducing couplings, mechanical-T style couplings, pressfit couplings, and plain end type couplings are not allowed.
 - 6. When mechanical couplings are used, ONLY grooved type fittings and pipe shall be used, no plain end fittings or pipe. Grooved couplings and fittings shall be manufactured by Victaulic, "Firelock" or approved equivalent.
- E. Water Flow Switches: Viking or approved equal water flow switch with adjustable retard feature. Switch shall be double-pole double-throw type and shall be rated at least 7 amperes at 125/250 volts.
- F. Valve Supervisory Switches:
 - 1. Provide on each valve, controlling or shutting-off sprinkler system where shown on drawings or/and on all valves required by NFPA 13, or any portion thereof.
 - 2. Provide UL listed unit, with either one single pole double throw switch or two single pole double throw switches as required. Switch shall be compatible with installed valve for standard mounting. Manufactured by Potter Roemer No. 6220, or approved equal.
- G. Sight Flow Connection: Provide acrylic sight flow connection in all test lines, conforming to NFPA 13.
- H. Pressure Gauges: Potter-Roemer Fig. No. 6240 or approved equal 3-1/2 inch diameter polished brass case, 1/4 inch NPT male connection, glass enclosed, 0-300 psi dial pressure gauges with isolation valves.
- I. All hangers and supports shall comply with NFPA 13.
- J. Fire Department Valve (FDV): Where required, provide Potter Roemer No. 4060-D, UL Listed and FM approved 2-1/2" cast-brass angle valve with iron hand-wheel, female inlet by 2-1/2" male NST hose thread outlet, 300 pound rating, with female NST hose thread cap with pin lugs and chain.

PART 2 - PRODUCTS

2.1 SPRINKLERS

- A. Unless otherwise specified, sprinkler heads shall be a quick response type with standard (155°F) temperature rated fusible link, 1/2 inch orifice and a 5.6 K factor.
 - 1. Heads located within the air streams of heat emitting equipment and serving Elevator Machine Rooms, Elevator Shafts and Boiler Rooms shall have an intermediate (200°F) temperature rated fusible link.
 - 2. Install corrosion-resistant sprinkler heads where they are exposed to weather, moisture, or corrosive vapors.
 - 3. Heads installed where they might receive mechanical injury or are less than 7 feet above the floor level shall be protected with approved guards in accordance with NFPA 13.
 - 4. Sprinklers in areas with suspended ceilings shall have pipe and fittings located above the suspended ceiling.
- C. Sprinkler heads shall be UL Listed and approved.
- D. Provide metal cabinet containing a stock of spare sprinkler heads of all types and ratings installed per NFPA 13.
 - 1. Locate cabinet where temperature will not exceed 100°F.
 - 2. Location shall be approved by the Owner.
 - 3. Number of spare sprinklers shall conform to NFPA 13.
 - 4. Provide a sprinkler wrench in the cabinet, for each different type sprinkler head.
- E. Sprinklers shall be provided in electrical rooms unless otherwise noted on the drawings.
- F. The use of extended coverage type heads must have prior approval.
- G. The use of UL listed flexible type head assemblies are permitted.

2.2 VALVE SUPERVISORY SWITCHES

- A. Contractor shall furnish and install supervisory switches. Coordinate wiring of switches with Electrical Contractor.

2.3 WATERFLOW SWITCHES

- A. Provide Viking VSR-F or equivalent waterflow switches, with adjustable retard feature in the supply pipe to each zone for remote alarm. Switch shall be double-pole single-throw type and shall be rated at least 7 amperes at 125/250 volts.
- B. Waterflow switches shall be furnished and installed by this Contractor and wired by Fire Alarm or Electrical Contractor. Coordinate wiring of flow switches with appropriate contractor.

2.4 BUILDING FIRE ALARM SYSTEM INTERFACE

- A. Each zone control assembly shall provide an alarm signal output to the Building Fire Alarm System whenever there is waterflow in the zone. Coordinate with Fire Alarm Contractor.
- B. Each valve which controls the flow of sprinkler system water shall be monitored by the Building Fire Alarm System. Coordinate with Fire Alarm Contractor.

2.5

2.6 SPRINKLER INSPECTOR'S TEST ASSEMBLY

- A. Provide NFPA 13 compliant UL Listed and approved sprinkler system inspector's test assembly, consisting of sight glass, tamper resistant test orifice, test and drain ball valve, rated for 300 psi, manufactured by AGF Model 1000, or approved equal.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having

jurisdiction.

- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Piping and joints shall be full bore reamed, for all joint types.
 - D. Slag shall be removed and cleaned at all welded joints.
 - E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
 - F. Install unions adjacent to each valve in pipes NPS 2" and smaller.
 - G. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
 - H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
 - I. Install sprinkler piping with drains for complete system drainage.
 - J. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
 - K. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
 - L. Install hangers and supports for sprinkler system piping according to NFPA13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 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.
- N. Fill sprinkler system piping completely with water.

3.2 PIPING INSTALLATION

- A. Piping shall be concealed, except by prior approval of Owner. Install all piping parallel to or at right angles to the column lines of the building wherever possible.
- B. Sprinklers in suspended ceilings shall be provided with arm over supply line.
- C. Individual sprinkler head piping shall not connect to cross-main from the bottom or side of cross-main.
- D. In electrical rooms, only sprinkler piping which serves the sprinkler heads in that room are allowed.
- E. Wet sprinklers shall not be located in IT closets or rooms without prior approval of Owner. Wet sprinkler piping shall not be located in IT closets or rooms. Provide a plugged, 1 inch "T" fitting outside of and in close proximity to each IT closet location for future branch line installation.
- F. Grade piping to eliminate traps and pockets and for drainage per NFPA 13. Where air pockets or water traps cannot be avoided, provide gate valves with hose connections for drainage.
- G. It shall be the responsibility of the Fire Protection Contractor to coordinate electrical equipment locations with the Electrical Contractor and design the fire protection piping system such that no piping is routed over electrical equipment, unless it serves that room.
- H. Changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole-cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the fire protection System Piping will cause that section of the piping to be cut out and replaced at the Contractor's expense.
- I. Pipe shall be reamed to full pipe diameter before joining:
 - 1. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only.
 - 2. Welded joints shall be made in accordance with the procedure outlined in the ANSI piping code.
 - 3. Valves and specialties shall be screwed or flanged joints.
 - 4. Grooved joints shall be made in accordance with manufacturers recommendations with UL listed and approved couplings or weld-o-let connections to pipe mains shall be full bore.
 - 5. Slag, etc. shall be removed.
- J. Install unions or flanges at equipment connections and as indicated on the Drawings.
- K. Cold-springing piping will not be permitted. Install piping with adequate support to prevent strain on the equipment and to allow for piping system expansion and contraction.

- L. Welded joints on pipe runs shall be made with continuous welds and with pipe ends beveled before fabrication. Piping shall be carefully aligned prior to welding and no metal shall project within the pipe.
- M. Piping shall be sized as required by applicable codes and as indicated on the Drawings.
- N. Provide all test and drain lines as required by Section 8.17.4.1, of NFPA 13:
 - 1. Pressure gauges, signs, and other such standard appurtenances shall be furnished as required for a complete installation in accordance with NFPA 13.
 - 2. Provide nameplate data sign at the zone controlling valve to identify the system as a hydraulically designed system indicating the location and basis for design in accordance with NFPA 13.
 - 1. Install sprinkler piping so that it can be thoroughly drained, and where practicable shall be arranged to drain at the zone drain valve. The zone drain valve shall be capable of a full discharge test without allowing water to flow onto the floor. All drips and drains shall conform to NFPA 13.
 - 2. Field changes in the piping layout or pipe sizes shall not be made without the prior approval of the Owner.

3.2 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of Cutting:
 - 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Owner.
 - 2. Impact-type equipment shall not be used except where specifically acceptable to the Owner.
 - 3. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.
- C. Restoration:
 - 1. All openings shall be restored to "as-new" condition for the materials involved, and shall match remaining surrounding materials and/or finishes.
- D. Masonry:
 - 1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
 - 2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
 - 3. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner.
- 4. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken. A Texas Registered Professional Engineer shall be consulted in these cases. Necessary structural repairs shall be designed by a Texas Registered Professional Engineer.

3.3 TESTS AND INSPECTIONS

- A. Inspections, examinations and tests required by the authorities or agencies specified shall be arranged and paid for by the Fire Protection Subcontractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Owner.
- B. Fire protection piping systems shall be hydrostatically tested by the Contractor upon completion of the installation as required by NFPA 13 in the presence of the Owners Representative.
 - 1. The fire protection piping systems shall be hydrostatically tested per the requirements listed in NFPA 13.
 - 2. When hydrostatic and alarm tests have been completed and all necessary corrections made, a material and test certification shall be provided in accordance with NFPA 13.
 - 3. Final inspection shall include full flow testing through the inspectors test connection.
 - 4. Actuation of the flow switch shall occur within one minute of opening of the inspector's test valve.
 - 5. Final tests shall be witnessed by the Owner's Representative.
- C. Sprinkler system zone control assemblies shall be tested to demonstrate proper operation of the flow switch and valve supervisory switch.
- D. Arrange and pay for all tests and inspections required by authorities having jurisdiction.
- E. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2" and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2" and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. 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.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 PERIODIC INSPECTION SERVICE

- A. After completion of the fire protection system installation and at the beginning of the guarantee period, the Automatic Sprinkler Subcontractor shall execute the National Automatic Sprinkler and Fire Control Association, Inc., Standard Form of "Inspection Agreement", without change in the Contract amount, calling for four inspections of the fire protection system during the warranty period.
- B. During the warranty period, inspections shall be in accordance with the Inspection Agreement, plus the following maintenance to be performed during the course of the fourth inspection:
 - 1. Operation of all control valves.
 - 2. Lubrication of operating stems of all interior valves.
 - 3. Operation of all alarms, supervisory switches, air compressors, alarm trip switches, flow switches, and similar items.
 - 4. Cleaning of alarm valves.
 - 5. Lubrication of Fire Department valve hose connections.
- 6. The standard form of the National Automatic Sprinkler and Fire Control Association, Inc., "Report of Inspection", shall be filled out in triplicate after each inspection and the copies sent to the Owner.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 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. Install check valve in each water-supply connection. Install double check, fire service rated backflow preventer in connection to potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.5 SPRINKLER AND COVER PLATE (RECESSED SPRINKLER HEADS) INSTALLATION

- A. Sprinkler heads and recessed sprinkler cover plates shall be protected from damage, dirt and other deleterious materials during construction. Remove and replace any damaged sprinkler or sprinkler cover plate, or sprinklers or cover plates having any foreign material other than factory finish. Sprinkler heads and cover plates shall not be cleaned unless by a method approved by the manufacturer AND accepted by the Owner.

3.6 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.7 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.8 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.

5. Start and run excess-pressure pumps.
 6. Coordinate with fire-alarm tests. Operate as required.
 7. Verify that equipment hose threads are NST.
 8. Sprinkler system zone control assemblies shall be tested to demonstrate proper operation of the flow switch and valve supervisory switch.
 9. Arrange & pay for all tests and inspections required by authorities having jurisdiction.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 PERIODIC INSPECTION SERVICE

- A. Provide periodic inspections service after completion and Owner acceptance.
- B. This agreement shall be executed at no cost to the Owner and shall include four inspections of the entire sprinkler system during the warranty period, each with a NASFCA "Report of Inspection to the Owner". The final inspection shall include operation and lubrication of all valves, cleaning of all alarm valves and operational testing of all system Electrical and alarm components.

3.12 TRAINING

- A. The installation contractor shall provide a minimum of 4 hours of training for the Owner in operation and maintenance of the wet-pipe and/or dry pipe sprinkler system.

END OF SECTION

UNIVERSITY OF NORTH TEXAS

**FIRE PUMPS
SECTION 213000**

PART 1 - GENERAL

1.1 SUMMARY

A. This section addresses electric fire pump motors, fire and jockey pumps, respective related controllers and specialty accessories incorporated into a building fire sprinkler system.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Fire and jockey pump cut sheets with all pump capacities, UL/FM approval, pump characteristics, features and accessories clearly indicated. Include pump motor brand name and performance data.
 - 2. Pump curves with selection point clearly indicated.
 - 3. Fire and jockey pump motors must be listed for fire pump use and meet NFPA 20 standards. Provide Totally Enclosed, Fan Cooled (TEFC) fire pump motors. Provide complete motor specifications and data.
 - a. U.S. Motor is not an acceptable motor manufacturer for fire pump motors.
 - 4. Fire Pump Controller Automatic Transfer Switch and cut sheets with features and options clearly indicated, wiring diagrams, nameplate text and a written system operational sequence.
 - 5. Jockey pump controller wiring diagram.
- C. Product Certificates: For each fire pump, from manufacturer.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Operation and maintenance data.

1.3 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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pumps, controllers, automatic transfer switch, and accessories in factory-fabricate water resistant wrapping.
- B. Handle pumps, controllers, automatic transfer switch, and accessories carefully to avoid damage to material components, enclosure, and finish.
- C. Store pumps, controllers, automatic transfer switch, and accessories in a clean, dry space and protect from the weather.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fire Pump:
 - a. S.A. Armstrong Limited.
 - b. A-C Fire Pump Systems; a business of ITT Industries.
 - c. Aurora.
 - d. Peerless Pump, Inc.
 - e. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
 - 2. Electric Fire Pump Motor:
 - a. Lincoln
 - b. WEG
 - c. Marathon
 - 3. Jockey Pump:
 - a. Grundfos.
 - b. Goulds.
 - c. S.A. Armstrong Limited.
 - 4. Fire Pump Controller:
 - a. Master.
 - b. Firetrol, Inc.
 - c. Metron.
 - d. Torna Tech

2.2 ELECTRIC FIRE PUMP SYSTEM

- A. General:
 - 1. Provide a complete and operational fire pumping system consisting of horizontal split case electric fire pump, jockey pump, combination fire pump controller/automatic transfer switch, jockey pump controller, flow testing equipment and associated components as specified and as scheduled and shown on Drawings.
 - 2. Equipment furnished and the complete installation shall be in accordance with NFPA 20. Pump and controller/automatic transfer switch shall bear the UL label.
 - 3. Refer to schedule on Drawings for pump size and design characteristics. Size of the fire pump is to be based on flow test information.
- B. Fire Pump:
 - 1. Electric driven fire pump shall be a horizontal split case centrifugal type, UL Listed, FM-approved and in compliance with all requirements of NFPA 20.

2. Pump shall be of bronze-fitted construction with Class 30 cast iron casing, bronze impeller, renewable bronze sleeves and bronze wear rings, packed stuffing boxes and grease lubricated ball bearings in motor.
3. Pump shaft shall be high strength steel.
4. Pump shaft deflection shall not exceed 0.002 inch at the stuffing boxes when operating at ± 25 percent of the best operating point.
- C. Pump suction flange shall be rated for 125 psi working pressure on inlet side and the discharge flange shall be rated for 250 psi working pressure.
 1. Fire pump shall be factory mounted on a pedestal and connected through a rigid split coupling. Motor shall have a 1.15 service factor shall be sized so as to not exceed the permissible loading limits of NFPA 20 at any point on the pump performance curve.
 2. Locked rotor current shall not exceed the values specified in NFPA 20.
 3. Each motor shall be of such capacity that at rated voltage under any pump operating condition, the full load ampere rating shall not be exceeded except as permitted by the service factor stamped on the motor nameplate.
 4. Motors shall be compatible with the specified motor controller.
 5. Motor electrical characteristics and capacity shall be as scheduled and shown on the Drawings.
- D. Fire pump capacity shall be as scheduled on Drawings.
- E. Pump shall be hydrostatically tested at 1.5 times the maximum working pressure but in no case less than 250 psig.
- F. Shutoff head of fire pump must exceed dead head of fire pump by 10 psi.
- G. Accessories:
 1. Provide pump accessories per NFPA 20, including, but not limited to:
 - a. 3/4" minimum casing overheat relief.
 - b. 3-1/2" dial liquid filled compound suction pressure gauge.
 - c. 3-1/2" dial liquid filled discharge pressure gauge.
 - d. Eccentric tapered suction reducer.
 - e. Concentric tapered discharge increaser.
 - f. Base-mounted coupling guard.
 - g. Fire pump accessories shall be approved for domestic water use.
 - h. All relief drains to floor drains.
- H. Factory Testing: Fire pump shall be factory tested and certified in accordance with NFPA 20. Certified performance test results and curves shall be delivered to the Owner for review prior to final fire pump acceptance.
- I. Field Service: Pump supplier shall provide pump checkout, start-up, testing and adjusting of system components and shall perform field certification testing on the installed fire pump. The pump supplier shall also train the Owners Engineer in the proper operation and maintenance of the fire pump system.

2.3 FIRE PUMP CONTROLLER/AUTOMATIC TRANSFER SWITCH

- A. The fire pump controller/automatic transfer switch shall be of the combined manual and automatic type, solid state reduced voltage, minimum, 100,000 amp withstand rated, full service, and UL listed and FM approved per NFPA 20 currently enforced. The fire pump controller/automatic transfer switch shall be housed in a NEMA 2 floor-mounted, non-vented enclosure, mounted on a 4" thick concrete pad, and include the following:

1. Isolation switch with a separate NEMA operating handle interlocked with circuit breaker.
 2. Time delay circuit breaker set at 300 percent motor full load current with external LED supervised locked rotor protector, instant and time delay trip test switch, and external NEMA operator handle.
 3. Differential adjustable pressure switch with energize to start relay.
 4. Minimum run timer, 10 minutes non-adjustable, with timed out LED indicator.
 5. POWER AVAILABLE and PHASE REVERSAL pilot lights wired to the line side of the motor starter. Indicating lights shall be long life LEDs.
 6. Digital ammeter and voltmeter with three phase selector switch, calibrated traceable to NBS standards.
 7. Built in alarm panel and supervisory power pilot light powered from separate reliable 120 VAC power source with lights, bell, silence button, and lamp test switch for indication of PUMP RUNNING, POWER FAILURE, PHASE REVERSAL, TRANSFER SWITCH IN EMERGENCY, ISOLATION SWITCH OPEN. A status panel for start and run demands shall also be included. All indicating lights shall be long life LEDs with lamp test feature.
 8. START and STOP pushbuttons for manual control.
 9. Two sets each of dry form "C" contacts for remote indication at main fire alarm panel for PUMP RUNNING, POWER FAILURE, PHASE REVERSAL, TRANSFER SWITCH IN EMERGENCY, ISOLATION SWITCH OPEN, and SUPERVISORY POWER FAILURE.
 10. Digital paperless alarm recorder.
 11. Three non-fused control power transformers, surge protector wired to the load side of the isolation switch with short circuit protection, magnetic contactors with externally operable mechanical start mechanism, and restart delay timer.
 12. Automatic transfer switch housed in a separate compartment of the fire pump controller. The transfer switch shall have normal power light and monitors, emergency power light and monitor, test switch, and time delays for generator start, transfer to emergency, and retransfer to normal. All control and monitor components shall be individually serviceable. Unit shall have, as a minimum, a 5 year warranty on parts and a 2 year warranty on labor.
 13. The fire pump controller and transfer switch shall be for fire pump scheduled horsepower, UL 1008 listed, 3 phase motor, rating for highest low voltage (i.e. 208, 240, 460) available at site. Manufactured by Firetrol No. FTA1900, or approved equal by Master or Metron.
- B. The fire pump controller/ATS shall also have the following control functions:
1. Provide an interlock between the fire pump controller and ATS that will, when the fire pump is running, inhibit the automatic transfer switch from "TRANSFERRING-TO-NORMAL" power source as long as the fire pump is operating on the "EMERGENCY" source.
 2. Interlock control wiring from the Fire Pump Controller to the Fire Pump Automatic Transfer Switch shall be factory-installed.

2.4 FIRE PUMP WIRE

- A. Electrical wiring for fire pump, jockey pump and associated controllers shall be installed by a Texas Department of Licensing and Regulations (TDLR) registered and licensed Electrical Contractor.
- B. Electrical supply conductors for the fire pump motor shall be sized according to NFPA 70 for Fire Pumps.
- C. Electrical supply conductors for the fire pump motor shall be capable of maintaining integrity and operation for a minimum of two hours under fire exposure condition. Acceptable wire is as follows:

1. Lifeline® Power Cable RHW-2 Two-Hour Fire Resistive Cable;
2. VitaLink® MC Two Hour Fire Rated Power Cable.

2.5 FLOW TESTING EQUIPMENT

- A. The fire pump supplier shall furnish a FM approved flow meter for testing the fire pump.
- B. The flow meter shall be flanged venturi type BV as manufactured by Aeroquip, or approved equal.
- C. The installing contractor shall submit approval drawings of the proposed piping layout, which shall conform to the requirements prescribed by the flow meter manufacturer.

2.6 FIRE PUMP TEST HEADER

- A. Provide wall mounted ductile iron body outlet fire pump test connection, complete with polished chrome plated exposed surfaces, with plate lettered "Pump Test Connection".
- B. Chrome plated brass NRS hose gate valves, with loose bonnet caps and chains, 2-1/2 inch gate valves with local fire department threads, back outlet, manufactured by Potter Roemer No. 5864-D-2, or approved equal.

2.7 JOCKEY PUMP

- A. General: Provide a complete and operational electric driven fire jockey pump and jockey pump controller as specified herein and as scheduled and as shown on the Drawings.
- B. Pump:
 1. The jockey pump shall be a centrifugal multi-stage pump with stainless steel impeller and shaft, and cast iron base, and EPDM O-rings.
 2. Jockey pump capacities shall be as scheduled on the Drawings.
 3. Pumps, casings, flanges, and mechanical seals shall be rated for operation with the working pressures scheduled.
- C. The jockey pump shall be mounted on a fabricated cast iron drip lip base and shall be close-coupled or flexible coupled to an energy efficient, high efficiency open drip-proof motor. Motor electrical characteristics and capacity shall be as scheduled or listed on the drawings.
- D. Relief Valve: Provide the fire jockey pump with a factory-mounted bypass relief valve complete with piping. Set relief valve to relieve at a pressure of 25 psig above design total dynamic head to prevent motor overload and system damage.
- E. Jockey Pump Controller: The electric jockey pump controller shall be UL listed and NFPA 70 compliant. Unit shall include a circuit breaker, magnetic starter with overloads, 0-300 psig pressure switch, H-O-A selector switch, minimum run timer, dual fused control transformer, two sets of remote form "C" contacts for pump running, and a NEMA 2 enclosure, Master control Model PMC series, or Firetrol Model FTA500, or Metron.
- F. Field Service: The pump supplier shall provide pump checkout, start-up, testing and adjusting of system components and shall perform field certification testing on the installed jockey pump. The pump supplier shall also train the Owners Representatives in the proper operation and maintenance of the jockey pump system.

2.8 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting: Install fire pumps and jockey pumps on concrete bases.
 - 1. Where not otherwise indicated, install 4 inch thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is allowed by prior approval.
 - 2. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade.
 - 3. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings.
 - 4. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.
 - 5. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.
 - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18" centers around the full perimeter of concrete base.

- b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- d. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 6. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
 - a. Equipment must be leveled and set plumb.
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
- D. Support piping and pumps separately so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping.
- F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings.
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to Electrical Contractor.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- J. Engage a factory-authorized service representative to perform startup service.
- K. Complete installation and startup checks according to manufacturer's written instructions.

3.3 ALIGNMENT

- A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment and to tolerances specified by manufacturer.

3.4 CONNECTIONS

- A. Comply with requirements for piping and valves specified in Section 21 13 13, Wet-Pipe Sprinkler Systems. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 6. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
 - 7. Prepare test and inspection reports.
- E. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps. Coordinate training with Owner.
- B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans.

END OF SECTION

**SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the common work results requirements for Division 22, Plumbing. Applicable provisions of this Section apply to all Sections of Division 22.

1.02 GENERAL

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements and provide coordination drawings.
- B. Prior to starting work, Contractor shall provide 1/4 inch scale coordination drawings for all areas of the buildings for approval by Architect/Engineer.
 - 1. Drawings shall show all equipment, ductwork, cable trays, fire protection systems, coil pull spaces, chilled water, heating water, and condensate piping and trap, electrical conduit, electrical control panels, etc. installed to verify space allocation and coordination of trades.
 - 2. Provide plan and elevation views detailing installation.
 - 3. Do not proceed with construction of plumbing systems until Drawings have been approved by Architect, Engineer, and Owner.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
- B. Resolve code violations discovered in contract documents with Engineer prior to award of Contract. After award of Contract, make correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. Obtain and pay for all permits and inspections.

1.05 SUBMITTALS

- A. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- B. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data at one time for review for items of equipment and for principal materials proposed for installation. Include identifying symbols and equipment

numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.

- C. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.
- D. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

1.06 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - a. Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number, and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair, and replacement procurement procedures.
 - g. Operating instructions including start-up and shutdown procedures.
 - h. Safety considerations including load limits, speed, temperature, and pressure.
- B. Provide O&M manuals for all plumbing equipment. Coordinate O&M manuals with Division 01.
- C. Upon completion of work, and at time designated by the Architect/Engineer, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system.

1.07 PROJECT RECORD DOCUMENTS

- A. Preparation:
 - 1. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
 - 2. Mark the drawings with a colored pencil.
 - 3. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed
 - 4. Include flow-line elevation of sewer lines.
 - 5. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.
 - 6. Coordinate requirements for Project Record Documents with Division 01.
- B. Deliver: At conclusion of project, obtain without cost to Owner, reproduces of original mechanical drawings and transfer as-built changes to these. Delivery of as-built prints and reproduces is a condition of final acceptance.

- C. Provide and post a laminated copy (3 total) of the following record drawings on 11" X 17" paper in the main electrical room, mechanical pump room, and mechanical penthouse.
 - 1. Drawings P10CB, P101A, P101B, P102A, P103A, P104A, P105A, P400, P402 with all Domestic and RO water isolation valves highlighted and tagged. Additionally highlight tag all valves used for draining the domestic and RO water systems. Reference 230010, 3.17, for domestic and RO drain procedures for additional clarification of service valve locations to be highlighted.

1.08 GUARANTEE

- A. Guarantee work for 1 year from the date of substantial completion of the project, and during that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship. Coordinate requirements for Warranty with Division 01.

1.09 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform service monthly, and provide the Owner with a written report. Cleaning of air filters and pipe strainers is not included.

1.10 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions (except where specified otherwise in individual sections), revisions, amendments or supplements in effect on date bids are received.
 - 1. Requirements in reference specifications and standards are minimum for all equipment, material and work.
 - 2. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.11 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of Cutting:
 - 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 - 2. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer.
 - 3. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.
- C. Restoration:
 - 1. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.
- D. Masonry:
 - 1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
 - 2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
 - 3. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- E. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

1.12 EXCAVATION, TRENCHING AND BACKFILL

- A. Excavation: See Divisions 00, 01, and 31 for special requirements related to excavation and trenching.
- B. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc.
- C. All exterior lines shall be installed with a minimum cover of 24 inches, unless otherwise indicated.
 - 1. Generally, more cover shall be provided if grade will permit.
 - 2. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector.
 - 3. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced.
 - 4. Trenches shall be not less than 12 inches wider or more than 16 inches wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6 inches or more than 8 inches in width is provided on each side of the pipe.
 - 5. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.
- D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints.
- E. Bell holes shall be dug after the trench bottom has been graded.
 - 1. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used.
 - 2. Bell holes for pipe joints shall be 12 inches in depth below the trench bottom and shall extend from a point 6 inches back of the face of the bell.
 - 3. Such bell holes shall be of sufficient width to provide ample room for caulking.
 - 4. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to ensure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench.
 - 5. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used.
 - 6. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.
 - 7. Special pipe beds shall be provided as specified hereinafter.
- F. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work.
 - 1. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place.
 - 2. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required.
 - 3. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6 inches below the trench depths specified.
 - 4. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand.

5. Whenever wet or otherwise unstable soil incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
- G. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Refer to appropriate Sections of Division 31.
- H. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided. Refer to appropriate Sections of Division 31.
- I. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12 inches for a distance of 24 inches on either side. Edges of such excavations shall slope at an angle of not over 45° with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
- J. Trenches for cast iron drain, storm water, and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped, and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
- K. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site.
- L. Backfilling:
 1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. Refer to appropriate Sections of Division 31 for additional requirements.
 2. Backfill under concrete slabs-on-fill shall be as per appropriate Sections of Division 31.
- M. Opening and Reclosing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. Refer to Division 31. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished.
- N. Excavation in Vicinity of Trees: Refer to Division 31.
- O. Welding Certificates: Provide current welding certificates.

1.13 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacturer where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed in individual Sections of Division 22. Manufacturer's names and catalog numbers specified under Sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturer's list will be accepted upon approval.
- B. Substitutions:
 - 1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
 - 2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
 - 3. The Architect/Engineer will not give approval to material salesmen or subcontractors and only in writing to the successful Contractor after the project has been awarded.
 - 4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
 - 5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
 - 6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest.
 - 7. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
 - 8. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural, or architectural, which may result from the substitution.
 - 9. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.03 PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service piping system strainers.
- B. Turn over to Owner additional sets of spare parts as specified.

2.04 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

2.05 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.06 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8" Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.
- F. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.07 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225°F.

2.08 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: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.09 SLEEVES

- A. Through Floors: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- B. Through Walls in Crawl Space: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- C. Sleeves Through Interior Walls: 22 gauge galvanized steel snap lock. No screws through vapor barrier.

2.10 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.

2.11 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section, Penetration Firestopping, for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections for roughing-in requirements.
- S. Provide fire rated type access panels in fire rated walls where indicated in drawings. Access panel to match or exceed to wall rating.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.03 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.05 OBSTRUCTIONS

- A. Drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.06 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.07 PROTECTION

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps. Provide adequate ventilation. At work completion, all work must be clean and in like new condition.
- C. Storage of all mechanical equipment and piping materials shall be in strict accordance with manufacturers written installation instructions.
- D. Provide factory installed pipe caps for all pipes to be installed on the project.

3.08 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, Cast-in-Place Concrete.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section, Metal Fabrications, for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.12 LUBRICATION AND OIL

- A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.13 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the University prior to submitting a written request for service.
- B. All equipment operated shall be serviced on a regular basis by the Contractor.
- C. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.
- D. All warranties will be commenced at the time of substantial completion.

3.14 OPERATING TESTS

- A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, and alarms. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual Sections.
- C. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.15 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - 2. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
 - 3. Special tools and equipment required for testing and maintenance.
 - 4. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
 - 5. Recommended spares by part number and nomenclature and spare stocking levels.
 - 6. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - 7. Troubleshooting, checkout, repair and replacement procurement procedures.
 - 8. Operating instructions including start up and shutdown procedures.
 - 9. Safety considerations including load limits, speed, temperature and pressure.
 - 10. Provide O&M manuals for all plumbing equipment. Coordinate requirements for O&M Manuals with Division 01.

3.16 OPERATING INSTRUCTIONS

- A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system. The training sessions will be video taped for instructing future technicians.
- B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 019113, General Commissioning, for contractor training requirements.
- C. Coordinate requirements for training with Division 01.

END OF SECTION

SECTION 22 0526 PIPE AND PIPE FITTINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for pipe and pipe fittings for all piping systems. This Section applies to all Plumbing Sections of Division 22 which employ pipe and pipe fittings. Fabricate and erect all piping in accordance with ASME/ANSI B31.9 except as otherwise indicated.

1.02 RELATED SECTIONS

- A. Division 07 - Thermal and moisture protection for firestopping requirements.
- B. Division 09 - Finishes for painting requirements.
- C. Section 22 05 00 - Common Work Results for Plumbing
- D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- E. Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment.
- F. Section 22 07 16 - Plumbing Equipment Insulation.
- G. Section 22 11 16 - Domestic Water Piping.
- H. Section 22 11 19 - Domestic Water Piping Specialties.
- I. Section 22 14 23.13 - Roof Drainage Piping Systems.

1.03 SUBMITTALS

- A. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 paragraphs where titles below introduce lists or manufacturers, the following requirements apply to product selection:
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified.

2.02 PIPE AND FITTINGS

- A. The particular type of pipe and fittings for each system is specified in the Section for that system. All piping and fittings shall be of U.S. Manufacturer. All pipe shall be shipped capped. Shipped and store on job site with ends capped from the factory.

2.03 JOINTS

- A. Screwed: Make screwed joints using machine-cut ANSI taper pipe threads. Apply a suitable joint compound, such as Teflon tape, to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.
- B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions such as Crane Company No. 1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.
- C. Solder Joints:
 - 1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 - 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.

3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.
- D. Welded Joints:
 1. Make welded joints as recommended by the standards of the American Welding Society.
 2. Ensure complete penetration of deposited metal with base metal.
 3. Provide filler metal suitable for use with base metal.
 4. Keep inside of fittings free from globules of weld metal.
 5. Do not use mitered joints.
 6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
- E. Flanged Joints:
 1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
 2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
 3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.
 4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use Coreten or galvanized steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.
 5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.
 6. Flanges for ductile iron pipe are specified in Sections using that pipe.
 7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.
- F. No Hub: Install according to manufacturer's recommendations, using recommended tools.
- G. Bell and Spigot: Use neoprene compression gaskets for sanitary and storm.
- H. Push-on Joints (Ductile Iron Pipe): Restrained joints and gaskets for ductile iron pipe are specified in Sections using that pipe.

2.04 UNIONS

- A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.05 BRANCH CONNECTIONS

- A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.
- B. For 2-1/2 Inches through 14 Inches: For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weld-O-Let when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.
- C. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the system piping will cause that section of the piping to be cut out and replaced at the Contractor's expense

2.06 GASKETS

- A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.
- B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16-inch-thick gasket.

2.07 FLOOR AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 EXECUTION

3.01 PIPE FABRICATION AND INSTALLATION

- A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work.
- B. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance. Install piping plumb and parallel with building walls.
- C. Do not cut or weaken any structural member.
- D. Cut all pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs.
- E. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending and mitering are prohibited. Make all connections to equipment using flanged joints or unions. Make reducing connections with reducing fittings only.
- F. All water piping installed above ground or below ground and in trenches, including preinsulated piping, must be installed by a licensed Mechanical Contractor at building rates. The wage rates for building trades apply only to the extent of work required to be installed by licensed Plumbing or Mechanical Contractors.

3.02 WELDING

- A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
- C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.03 OFFSETS AND FITTINGS

- A. Because of the small scale of Drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.
- B. Install all piping close to walls, ceilings, and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

3.04 PIPE SLEEVES

- A. Fit with sleeves all pipes passing through gyp board, masonry, and concrete construction, refer to specification section 22 05 00 and the following:
 - 1. Provide 20 gauge wall sleeves for pipes passing through gyp board walls.
 - 2. Fabricate floor sleeves of schedule 40 weight galvanized steel pipe and masonry wall sleeves of 20 gauge galvanized steel.
 - 3. Size sleeve for minimum clearance between pipe or insulation and sleeve.
 - 4. All sleeves in wet lab areas to have a welded waterstop.
 - 5. All sleeves shall be hot dipped galvanized after fabrication.
- B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.
- C. Seal all sleeves water and airtight. Seal annular space between pipes and sleeves with compound with flame and smoke spread rating of minimum 25/50 in accordance with ASTM E 84 test.
- D. Sleeves below grades in outside walls are detailed on drawings. Except as shown otherwise, provide Thunderline Link-Seal or approved equivalent with stainless steel nuts and bolts, with cast iron pressure plate.

3.05 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving all equipment, and at other locations as indicated and required for isolation of piping or equipment.

3.06 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained. Install a 2 inch drain for 2-inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches. Provide hose adapter and cap on all drain lines.
- B. Provide automatic vents with isolation valves or manual vents at locations as indicated on drawings and all high points in piping systems.

3.07 CLEANING OF PIPING SYSTEMS

- A. Cleaning of piping system must be performed by an independent agency specializing in this type of work:
 - 1. The agency must have a minimum of 5 years experience with at least three projects of similar size.
 - 2. Submit project names for review.
- B. Minimum velocity of 10 feet per second must be maintained in the pipes during flushing period:
 - 1. Do not use building pumps for circulating water.
 - 2. Provide temporary pumps as required to achieve minimum velocities.
 - 3. Remove flow meters from building piping during flushing operation.
 - 4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
- C. Submit a detailed plan for the Engineer's and Owner's review and approval describing in full detail the individual steps associated with this process before any piping is installed:
 - 1. Plan must include a drawing indicating GPM's required to provide minimum velocity required in the piping, phasing of systems being cleaned, locations of drains or other temporary connections required for cleaning system, and cutsheet of temporary pump proposed.
- D. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating.

- E. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.
- F. Domestic Water Piping:
 - 1. All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized.
 - 2. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated.
 - 3. The solution will be allowed to stand for a period of 24 hours.
 - 4. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours.
 - 5. After sterilization, all piping shall be thoroughly flushed.
 - 6. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.
 - 7. Under no circumstances shall the Contractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified by the authorities having jurisdiction.
- G. Special requirements, if any, are specified in the Sections for each type of piping.
- H. After systems have been flushed, cleaned and sterilized; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use.

3.08 LEAK TESTS

- A. All piping systems shall demonstrate leak tightness. This requirement shall be met by a water hydrostatic leak test or a pneumatic leak test, whichever is called for under specific piping Sections.
- B. Piping Systems:
 - 1. Test Preparation: Expansion joints shall be provided with temporary restraint, for the additional pressure load under test or shall be isolated from the test. Equipment and valves which are not rated for the pressure test shall be either disconnected from the piping or isolated by a blind flange or similar means.
 - 2. Test Pressure: The water hydrostatic test pressure shall be 1.5 times the design pressure. The pressure test shall be maintained for sufficient time to inspect all joints, with a minimum time of four hours.
 - 3. Special requirements, if any, for each system are specified in the Section for that system.

3.09 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Provide service connections to items of equipment furnished by others:
 - 1. Detailed shop drawings of equipment will be furnished indicating the exact number and location of rough-in points.
 - 2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
 - 3. Making adjustments to field conditions is considered a part of the work required.
- B. Roughing-In:
 - 1. When roughing-in, extend service piping to various items of equipment.
 - 2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
 - 3. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.
- C. Stop Valves:
 - 1. Provide stop valves for each service at rough-in locations, except for drains.
 - 2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. Refer to Specification 22 05 00.4, Common Work Results for Plumbing, for requirements that must be completed prior to requesting the Owner to provide chilled water or hot water from the building distribution system.

3.11 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.

END OF SECTION

**SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Division 03 Section, Concrete, for concrete requirements.
- C. Division 05 Section, Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- D. Division 09 Section, Painting, for painting requirements.
- E. Section 21 13 00 - Fire-Suppression Systems, for pipe hangers for fire-suppression piping.
- F. Section 22 05 00 - Common Work Results for Plumbing
- G. Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment, for vibration isolation devices.

1.02 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.03 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.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Anvil
- B. Cooper B-Line
- C. Erico

- D. Unistrut
- E. Nibco
- F. PHP

2.02 CLEVIS TYPE HANGERS

- A. Adjustable steel clevis hangers (MSS1 Type 1), similar to Anvil Figure 260.

2.03 METAL FRAMING SYSTEMS

- A. Provide fabricated cadmium plated steel framing members and appurtenances for interior pipe supports as shown:
 - 1. Mult-A-Frame, Unistrut, Cooper B-Line and Power-Strut pipe support systems also are acceptable.
 - 2. Support piping from precast and pan joist structure as detailed on Drawings.
 - 3. Powder actuated anchors are not permitted.
 - 4. Sleeves penetrating beams must be submitted through Structural Engineer. Refer to plumbing drawings for locations.
- B. Framing channel type support systems shall be 12-gauge cold-formed carbon steel conforming to ASTM A570 GR33:
 - 1. Fittings for framing channel system shall be punch pressed electro-galvanized carbon steel conforming to ASTM A575, A576, A635 and A36.
 - 2. Bolts and nuts shall have unified coarse screw threads with standard 1/2 inch nuts, conforming to ASTM A576 GR1015 AND ASTM A307.
 - 3. Components shall have an electro-plated zinc coating conforming to ASTM B633 SC1 or SC3, except where outdoors where a hot dipped galvanized coating conforming to ASTM A123 shall be used.

2.04 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.05 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. 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 with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 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.

2.07 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Concrete: Provide 3,000 psi concrete. Reinforce slab with No. 4 rebar on 12-inch center each way centered in slab unless indicated otherwise on Drawings.
- C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

2.09 SUPPORTS AND HANGERS WITHIN WALLS AND CHASES

- A. Where plumbing piping is located in walls and chases it shall be supported and clamped with factory supplied commercial support assemblies, inserts and clamps as manufactured by Holdrite, or approved equal.

PART 3 EXECUTION

3.01 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. Metallic coatings for piping and equipment that will not have field-applied finish. All hangers and supports shall be electro-plated zinc per ASTM B633 SC1 or SC3, except hangers, framing channels, supports and other associated hardware in crawl space shall be hot dipped galvanized conforming to ASTM A123.
- 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. 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.
- 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°F to 450°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-joist construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. 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.
 - 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.
- O. All exposed hangers and supports within areas with wash down hoses and areas where washdown can occur, shall have a hot dipped galvanized finish.
- P. Supports and hangers for piping within Greenhouse shall be type 316 stainless steel.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Steel 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 building structure.
- B. 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 herein for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- 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 mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- H. Install hangers and supports to allow controlled thermal 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. 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.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- M. 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 B31.9 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.
- N. Do not support piping from other piping.
- O. Where uninsulated (bare) copper pipe is supported by clevis hangers and riser clamps. The hangers shall be plastic coated or copper.
- P. Where uninsulated (bare) copper pipe is clamped to a dissimilar metal, such as steel, the copper pipe shall be installed with a felt isolator or Vibra Cushion No. B1999 manufactured by B-Line, Erico "Caddy" Cushion Clamp, or approved equal.
- Q. Isolation tape wrap is only acceptable where a clamp or support does not occur and where pipe is in connect with a building element.
- R. Place hangers not more than 6 feet apart on 1/2 inch and 3/4 inch pipes, or 10 feet apart on larger pipes unless noted otherwise on plans. Place hangers not more than 6 feet apart for all sizes of polyvinyl chloride pipe. Refer to manufacturer's recommendations for supporting polypropylene piping. For copper piping, place hangers as follows:
 - 1. For sizes up to 1 inch – maximum 5 feet - 0 inches O.C.
 - 2. For sizes 1-1/4 inch to 1-1/2 inch – maximum 7 feet - 0 inches O.C.
 - 3. For sizes 2 inches to 3 inches and larger – maximum 9 feet - 0 inches O.C.
- S. Support vertical risers as detailed on drawings at every floor:
 - 1. All water piping 2 inches or smaller shall be supported with galvanized steel strap pipe clamps of approved designed and sizes, properly supported at every floor.

- 2. Support piping assemblies in chases adequately enough to be rigid and self-supporting before the chase is closed.
- 3. Provide adequate structural support for piping penetrating chase walls to fixtures.
- T. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation Section.
- U. Perforated bar hangers, straps, wires or chains are not permitted.
- V. For cast iron piping, refer to specification section 22 13 16.

3.03 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.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- 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 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 contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.06 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.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.03 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.

1.04 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

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.
 - 3. Seton Identification Products.

2.02 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: Background to contrast with letter color.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 4 inches wide X 1-1/2 inches high.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the 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.

2.03 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. 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.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.04 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
1. Stencil Material: Brass.
 2. Paint: Standardized colors for the piping systems shall be per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

SYSTEM	COLOR
Domestic Water, Cold, Hot or Hot Water Return, RO Water	Blue, comparable to ICI/Glidden #1330
Natural Gas	Yellow (Paint entire pipe)
Compressed Air, Vacuum	White
Fire Water	Red

SYSTEM	COLOR
Drain Lines	Black, comparable to ICI/Glidden #1484

- B. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

BAND AND LETTER SIZE ALL DIMENSIONS IN INCHES		
Outside Diameter of Pipe Covering	Width of Color Band	Size of Letters and Numerals
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

1. Pipe Identification: Identify pipe at wall penetrations, machine or tank connections, and at not over 50 foot intervals. Marker identification shall be legible and should be visible from the floor. Stick-on type or plastic wrap-on markers are not acceptable. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

SERVICE	MARK
Domestic Water Supply	Dom-W-S
Domestic Hot Water Return	Dom-HW-R
Domestic Hot Water Supply	Dom-HW-S
Storm Sewer	Storm
Overflow Drain	Overflow
Sanitary Sewer	San
Sanitary Vent	San-V
Lab Air (100 psi)	Air-100 psi
Lab Air (50 psi)	Lab-Air- 50 psi
Lab Vacuum	Lab-Vac
RO Water Supply	ROS
RO Water Return	ROR
Lab Waste	Acid-W
Lab Vent	Acid-V
Natural Gas	Nat-Gas

2.05 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 8-1/2 X 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 X 5-1/4 inches minimum.
 - 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

3.01 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Equipment to be identified with plastic nameplates includes but is not limited to water heaters, filters, plumbing equipment, tanks, and water treatment devices.
- B. Identify small devices, such as in-line pumps with metal tags.
- C. Identify valves with tags.

3.03 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. 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.

3.05 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.
- B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner's Representative.

3.06 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

**SECTION 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section Includes:
 - 1. Insulation Materials:
 - a. Fiberglass insulation.
 - b. Closed Cell Elastomeric
 - 2. Sealant, adhesives and finishes.
 - 3. Jackets:
 - a. PVC jackets.
 - b. Canvas or glass jackets.
 - c. Aluminum type jackets.
- B. Related Sections include the following:
 - 1. Section 22 05 00 - Common Work Results for Plumbing
 - 2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
 - 3. Section 22 11 16 - Domestic Water Piping Systems
 - 4. Section 22 13 16 - Sanitary Waste and Vent Piping

1.02 REFERENCES

- A. ASHRAE 90.1 – Energy-Efficient design of New Buildings Except Low-Rise Residential Buildings; 2010.
- B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2004.
- C. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2000.
- D. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.
- E. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation, 2006.
- F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials, 2005.
- G. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association, 2009.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc., 2003.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thicknesses for equipment scheduled.
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.

- C. Samples: Submit samples of each type of insulation to display the material, quality, and application method.
 - 1. Obtain approval of sample application before proceeding with work.
- D. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- E. Field quality-control reports.

1.04 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. Surface Burning Characteristics: Flame spread/smoke developed index of 25/50 maximum when tested in accordance with ASTM E 94, NFPA 255, or UL 723.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified with minimum 5 years' experience.
- C. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 INSULATION

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johns Manville.
 - 2. Knauff Insulation.
 - 3. Owens Corning.
 - 4. Foster
 - 5. Childers
 - 6. Armacell: AP Armaflex
 - 7. Aeroflex USA
- B. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- C. Type A: Fiberglass (Glass Mineral Wool) Insulation; Bonded with a bio-based, formaldehyde free thermosetting resin. Type I, 850 deg. F (454 deg. C) or Type IV 1000 deg. F (538 deg. C). UL/ULC Classified per UL 723. Comply with ASTM C 585, ASTM C 411, ASTM C 795, and ASTM C 547, Type I, and Type IV, with k factor of 0.23 BTU/ft²/F/hr/inch at 75 degrees F.
 - 1. Pipe insulation is designated by K factor; NOT density. The density typically ranges from 4 PCF to 7 PCF; depending on the size/thickness in order to meet the k curve value)
 - 2. Factory applied aluminum foil reinforced inner and paper outer factory covering. (All Service Jacket – ASJ+ or ASJ): with Self-Sealing Lap Closure System (SSL+ or SSL).

3. Additionally, provide hard aluminum metal jacket or reinforced aluminum foil jacket where indicated herein.
 4. Knauf Earthwool 1000 Degree Pipe Insulation or approved equal.
- D. Type B: Closed Cell Elastomeric
1. Thermal Conductivity: K-value of 0.28 BTU-In/Hr.-degree F or less at 75 degrees F.
 2. Rated maximum service temperature of 300°F.
 3. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
 4. Certified to meet the requirements of ASTM C795 for use over stainless steel.
 5. Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint.
 6. Shall meet or exceed requirements of ASTM C534, Type I, tubular grade.

2.02 SEALANT, ADHESIVE, AND FINISH

- A. Type A Insulation (Fiberglass – Low Temperature (below 100°F):
1. Sealant: Childers CP-34, CP-35, CP-30LO or Foster 95-44 elastomeric sealant at valve covers, anchors, and hangers.
 2. Adhesive: When pressure sensitive adhesive closures are not supplied or when additional vapor-retardant facings are to be applied, provide Foster 85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 3. Finish: Childers CP-34 or Foster 30-65 vapor retarder coating and Childers Chil Glas No 10 glass or Foster Mast a Fab polyester cloth.
- B. Type A Insulation (Fiberglass – High Temperature (above 100°F):
1. Adhesive: Foster 85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 2. Finish: Childers CP-10 or CP-11 or Foster 46-50 with No. 10 glass cloth. Alternately same mastic used in paragraph 2.2A may be used for consistency during application.
 3. Cement: Ramco Thermokote on insulated fittings, flanges, and valves.
 4. Sealant: Childers CP-50AMV1 diluted 50% in water to prime cement prior to applying coating.
- C. Type B Insulation (Elastomeric):
1. Adhesive: When factory applied pressure-sensitive closure is not available furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75, or Childers CP-82 to seal longitudinal laps and to adhere butt joint covers.
 2. Finish: Furnish Aeroflex USA Aerocoat water based latex enamel finish or Foster 46-50 or Childers CP-11 coating.

2.03 FACTORY-APPLIED JACKETS

- A. ASJ+-SSL+: ASJ+ jacket with Self-Sealing Advanced Closure System; complying with ASTM C 1136 Type I, II, III, IV, and VII secured with self-sealing longitudinal laps and matching ASJ+ butt wraps.
- B. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a white kraft paper interleaving with an outer polymer film leaving no paper exposed; complying with ASTM C 1136 Type I, II, III, IV, and VII.
- C. ASJ: White, kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
- D. ASJ-SSL: ASJ with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.04 JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Canvas or Glass Jackets, Indoor Only: UL listed cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers 50AMV1 or Foster 81-42/30-36 lagging adhesive or approved equal.

- C. Hard Aluminum Metal Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - 1. Piping: Prefabricated jacket of ASTM B 209 aluminum, 0.020 inches thick with factory applied 2 mil moisture barrier for finishing interior insulated pipe.
 - 2. Valves, Fittings, and Flanges: ASTM B 209 aluminum covers, 0.020 inches thick providing complete coverage of all valves, fittings, and flanges.
 - 3. Straps and Seals: 1 inch x 0.010 inch ASTM B 209 aluminum strapping and seals for applying aluminum jacket and covers to provide weather-tight covering of all insulation including caps, flanges, and end of lines.
- D. Reinforced Aluminum Foil Jacket: Provide service reinforced vapor barrier jacket with integral laminated aluminum vapor barrier manufactured by Foster Vaporfas 62-05 or Venture Clad 1577CW.

PART 3 EXECUTION

3.01 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 apply 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install materials in accordance with manufacturer's instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.

- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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.
 - 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.
 - 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 pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.
- Q. For piping systems being heat traced, provide insulation one pipe size larger to accommodate the heat tracing cable.
- R. 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.
- S. On piping where tracing will be installed the insulation size shall be 1 pipe size larger to accommodate the heat trace cable. Strictly follow the heat tracing system manufacturer's recommendations where insulating the piping system.

3.03 PIPING INSTALLATION

- A. Complete pressure testing of piping systems prior to application of insulation.
- B. Fiberglass Pipes: Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.
- C. Fiberglass Low Temperature (below 100°F): Where piping is interrupted by fittings, flanges, valves or hangers, and at intervals not to exceed 25 feet on straight runs, form an isolating seal between the vapor barrier jacket and the bare pipe by liberal application of the sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to and along 2 inches of the jacket. Not required for storm piping or domestic water piping.

3.04 VALVES, FLANGES, AND FITTINGS

- A. Fiberglass – Low Temperature (below 100°F):
 - 1. Insulate valves, flanges, and fittings with pre-molded fitting secured with wire. Thickness of insulation shall be equal to that adjoining piping and shall match density or greater.
 - 2. Finish with 1/4-inch layer of Foster 30-65 or Childers CP-34 reinforced with Foster Mast a Fab or Childers Chil Galss No. 10 glass/polyester fabric.
- B. Fiberglass – High Temperature (above 100°F):
 - 1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.

2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded or gored fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with coating reinforced with white 10 inch x 10 inch glass fabric.
3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe. At Contractor's option, provide molded or mitered fittings, finished with Foster 46-50 or Childers CP-10/11 breather coating reinforced with glass fabric.
4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with molded or mitered fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with breather coating reinforced with white glass fabric.

3.05 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with glass cloth and two coats of finish.

3.06 SHIELDS AND HANGERS

- A. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe.
 1. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.
 2. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal.
 3. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.07 ALUMINUM TYPE JACKETING

- A. Apply aluminum type jacketing jacket and covers according to manufacturer's recommendations, completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
- B. Hard aluminum metal jacketing shall be installed using aluminum strapping and seals to provide complete weathertight covering. Provide hard aluminum jacket for all piping in mechanical rooms and mechanical penthouses within 84-inches of finished floor.
- C. Provide aluminum foil jacketing in crawl spaces and in mechanical equipment rooms and mechanical penthouses above 84" from finished floor.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if inspection reveals noncompliance with requirements.

3.09 INSULATION SCHEDULE

- A. Provide insulation with thickness and conductivity values in compliance with ASHRAE Standard 90.1, but not less than thicknesses scheduled below:

	TYPE	PIPE SIZES	INSULATION THICKNESS- INCHES
AHU Condensate Drains	A	All Sizes	1
All Domestic Cold Water and Domestic Hot Water serving single fixtures.	A		1/2
Domestic Hot Water Supply and Return	A	1-1/2" and smaller	1
Domestic Hot Water Supply and Return	A	2" and larger	1-1/2
Drinking Fountain Drains	A	All sizes	1
Floor Drain Bodies and Drain Lines receiving AHU Condensate. Insulate from floor drain to a minimum 20' of pipe run.	A	All sizes	1
All Domestic Cold Water, and Makeup Water	A	All sizes	1

1. Refer to floor plans for any additional locations for insulating piping due to acoustical concerns.

END OF SECTION

SECTION 22 1116 DOMESTIC WATER PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installing domestic hot and cold water piping, including hot water return, and makeup water.

1.02 RELATED SECTIONS

- A. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- B. Section 22 05 00 - Common Work Results for Plumbing
- C. Section 22 07 19 - Plumbing Piping Insulation.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with UL classified in accordance with ANSI/NSF 61 for hot and cold potable water service and shall be certified to the low lead requirements of NSF-372 for potable domestic water piping and components. Manufacturer must provide written documentation of compliance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements provide indicated products by manufacturers listed.
 - 1. Valves:
 - a. Apollo.
 - b. Crane.
 - c. Nibco.
 - d. Keystone.
 - e. Watts.
 - f. Milwaukee.
 - g. Hammond.
 - 2. Vacuum Breakers and Backflow Preventers:
 - a. Watts.
 - b. Wilkins.
 - c. Apollo
 - 3. Thermostatic Mixing Valves:
 - a. Lawler.
 - b. Bradley.
 - c. Powers.

2.02 PIPING AND FITTINGS

- A. Underground Piping:
 - 1. Sizes less than 4 inch: Provide ASTM B 88, hard-drawn, Type K copper water tube with wrought copper fittings with socket ends, ANSI B16.22. Provide Sil-Fos lead-free solder for all solder joints. Underground copper piping shall have a protective flexible poly material sleeve fully encasing pipe and fittings, similar to IPS Protect-O-Sleeve.

2. Sizes 4 inch and over: Provide Class 300 ductile iron pipe cement lined interior with compression joints, ANSI A21.6 and ANSI/AWWA C151/A21.51.
 - a. Cement-lined ductile iron fittings, conforming to ANSI A21.10 and A21.4 with mechanical joints with rubber gaskets.
 - b. Asphaltic outside coating on pipe and fittings.
 - c. Factory applied asphaltic coating on outside of pipe and fittings.
- B. Aboveground (Including Trap Primer Piping): Provide seamless, ASTM B 88, Type L copper water tube with ANSI B16.22 wrought copper fittings with socket ends. Lead-free solder for all solder joints, Alloy Grade E in accordance with ASTM B32, similar to Engelhard Silvacore 100. Joints for pipe fittings 2" and larger may be grooved type joints. Grooved End Fittings: All grooved end fittings shall be ANSI B16.18 cast bronze or ANSI B16.22 wrought copper, with copper-tube dimensioned grooved ends. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Couplings shall consist of two ductile iron housing segments cast with offsetting angle-pattern bolt pads, pressure responsive grade EHP gasket, and zinc-electroplated steel bolts and nuts. Couplings shall be installation-ready, for direct stab installation without field disassembly. Victaulic Style 607. Flange Adapter Victaulic Style 641 roll grooved copper-tube dimensioned fittings sized 2" and larger. For pipe sizes 4" and less pressed type joints may be used instead of soldered type joints or grooved joints. Pressed type joints shall be Viega Pro-Press or ApolloXPress joining method with a non-toxic synthetic rubber elastomer seal (EPDM O-RINGS) with the fitting socket. The fitting shall be pressed under substantial pressure by power tool forming a joint rated for 200 psi and tested for 600 psi, approved by IAPMO IGC 137-99/PS 117-2000 & ANSI/NSF 61, fitting material shall conform to ANSI/ASM B16.22 & B16.18, approved by International Plumbing Code 2021. When pressed type fittings are used only one manufacturer components shall be used on the entire project, mixing fittings by different manufacturers is prohibited. 3/8" diameter copper tube is allowed only where serving a single lavatory with a 0.5 gpm flow control device.
- C. Unions: ANSI B16.22 Class 150, 300-pound water-oil-gas service wrought solder joint fitting such as NIBCO 633/733 union C x C, or approved equal.
 1. Flange joints larger than 2 inches shall be brass.
 2. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.
 3. Dielectric waterway fittings with grooved and/or threaded ends, as manufactured by Victaulic Company, Series 647, for sizes 1/2" through 8

2.03 VALVES

- A. Comply with requirements in Section 22 11 19, Domestic Water Piping Specialties, for balancing valves, drain valves, backflow preventers, and vacuum breakers.
- B. Ball Valves (pipe sizes through 2 inches): 600 psi WOG, cast silicone bronze body, ASTM B584 Alloy C87600, two piece reinforced Teflon seats, full port, blowout proof stem, quarter turn handle with stainless steel ball and stem with threaded ends, manufactured by NIBCO No. T-585-66-LF or approved equal.
- C. Check Valves:
 1. 2 inches and smaller: Class 125, horizontal swing silicone bronze disc, with bodies and caps conforming to ASTM B 584 Alloy 87850 cast silicone bronze material, threaded ends, manufactured by NIBCO No. T-413-Y-LF or approved equal.
 2. 2-1/2 inches and larger: Class 125, iron body, globe style, renewable seat and disc, spring actuated, lead free, conforming to NSF/ANSI 61 & 372, MSS SP-125, FM approved. For flanged systems - Nibco Model F-910-B-LF, or approved equal. For grooved piping systems - Nibco Model G-920-W-LF, or approved equal.

- D. Butterfly Valves (2-1/2 inch and larger): Class 150, ductile iron body conforming to ASTM A-395, fully lugged, drilled body, lever operated, blow out proof type aluminum bronze disc and stem, EPDM seat, suitable for bi-directional dead end service with downstream flange removed, minimum 175 psi bubble tight shut-off, manufactured by NIBCO No. LD-2000, or approved equal. For grooved systems Victaulic Series 608N or NIBCO GD-4765 are acceptable.
- E. Domestic Hot Water Circulation Loop Circuit Setter (Balancing Valve): Self-contained fully automatic, constructed of type 303 stainless steel, rated for 200 psig maximum working pressure, thermal actuated, self-cleaning, spring loaded, designed for hot water system set to close at 140 degrees F (fully open at 130 degrees F), ANSI/NSF 61 certified, complete with check valve and lead free ball valve on inlet and outlet side of valve, manufactured by ThermOmegaTech "CircuitSolver" No. CSUA-3/4-XXX-CV-03, or approved equal.

2.04 STRAINERS

- A. Y type, for pipe sizes 2 inch and less, class 125 rated for working pressure through 400 psig WOG at 210°F, threaded ends, threaded cap, lead free, cast copper silicon alloy body and cap, type 304 stainless steel perforated screen, openings not larger than 1/32 inch, tapped blowout outlet with minimum size of 3/8 inch, similar to Watts LF777S or approved equal.
- B. Y type, for pipe sizes over 2 inch, class 125 rated for working pressure of 200 psig at 150 degrees F, lead free, flanged ends, ASTM A126-B cast iron body, ASTM A36 carbon steel cover, non-asbestos gasket, type 304 perforated stainless steel screen, 1/16 inch perforations for pipe sizes up through 4 inch and 1/8 inch perforations for pipe sizes over 4 inch, with FDA approved internal lining. Manufactured by Watts No. 77F-DI-FDA-125 or approved equal.

2.05 VACUUM BREAKERS AND BACKFLOW PREVENTERS

- A. Atmospheric Vacuum Breakers: Full line size, manufactured of brass or bronze with full size orifice, dry guide out of the liquid pressure area and disc float closing vent with minimum flow. Manufactured by Watts Regulator, No. 288A Series, or approved equal by Wilkens or Apollo.
- B. Pressure Type Vacuum Breaker: Full line size, with full size orifices, manufactured of brass or bronze with double poppit (check valve) stainless steel screen and vent. Manufactured by Watts Regulator, No. LF800M4QT, or approved equal by Wilkens or Apollo.
- C. Reduced Pressure Backflow Preventer: Size as indicated on Drawings, manufactured of bronze, rated for 175 psi, and shall include strainer, gate or ball valves based on size, pressure differential relief valve, check valves, test cocks, and relief vent and funnel drain.
 - 1. Unit shall meet the requirements of ASSE 1013, and AWWA, University of Southern California tested and approved.
 - 2. Manufactured by Watts Regulator No. 919QT for sizes 2" and less, and No. 957 for sizes over 2-inch, or approved equal by Wilkens or Apollo.
- D. Vacuum Relief Valve: 3/4 inch bronze with high temperature resisting disc, and disc guide located out of water.
 - 1. Tested up to 200 psi and 250°F and shall be open on a vacuum of not more than 1/2 inch of mercury.
 - 2. Manufactured by Watts Regulator No. N36g, or approved equal by Wilkens or Apollo.
- E. Pressure Type High hazard, anti-siphon, anti-spill, vacuum breaker designed for indoor applications, featuring bronze body, one-piece modular check valve and float assembly, stainless steel springs, bronze quarter turn ball valves at inlet and discharge, University of Southern California tested and approved. Manufactured by Watts No. LF800M4QT, or approved equal by Wilkens or Apollo.
- F. Dual Check Valve: Tested and certified to meet ANSI/ASSE Standard 1024, testable, cast bronze body, silicone discs, stainless steel springs, manufactured by Watts Series LF7, or approved equal.

2.06 AIR RELIEF VENTS

- A. Float operated, constructed of cast iron with stainless steel float and trim and isolating valve:

1. 1/2 inch, rated at 300 psi at 150°F.
 2. Vents shall be designed to eliminate air from the system automatically without permitting the passage of water.
 3. Minimum 3/4 inch system connection (inlet), minimum 1/2 inch drain connection (outlet), 1/4 inch drilled, tapped and plugged test connection.
 4. Manufactured by Clark-Reliance, Model No. 6-V, or approved equal.
- B. For sizes under 2" (Point of Use at Equipment Connections): Automatic in operation, adjustable, renewable stainless steel seat, bronze body, adjustable from 25-75 psi outlet pressure, with stainless steel strainer screen, with gauge tappings, manufactured by Watts No. U5B, or approved equal.

2.07 P-TRAP SEAL PROTECTION

- A. Provide ASSE 1072 compliant Rectorseal Floor Drain Trap Sealer (Sure Seal) in all floor drains and floor sinks where electronic trap primers are not indicated on the drawings.
- B. Electronic Trap Primer Type: Electronic trap priming manifold, surface mounted, complete with resettable timer, factory assembled, pre-piped bronze body, 3/4" NPT, 3/4" solenoid valve, Type "L" copper manifold with brass 1/2" compression fittings with single point 120 volt electrical connection with manual override switch, 16 gauge steel enclosure with integral atmospheric vacuum breaker, with mounting anchors, manufactured by PPP Inc., "Prime Time" or approved equal.

2.08 THERMOSTATIC MIXING VALVES

- A. Provide rough bronze construction with a flow range of 1/2 gpm (minimum) through 4.5 gpm at 5 psi pressure loss with integral true service spring loaded check stops (rubber type duck bill check valves are not allowed) and dual stainless steel strainers on inlets, temperature adjustment range 60°F to 140°F, ASSE 1017/1070 compliant, outlet temperature set at 110°F at Sinks and 105°F at the Lavatories in Restrooms, rough chrome or brass finish on valve body. Provide mixing valve in recessed stainless steel cabinet with lockable door where wall mounted fixtures occur. Check stops shall allow water to be shutoff to mixing valve for cartridge maintenance, Manufactured by Symmons 7-225-B-CK-MS-X-T, or approved equal by Powers or Bradley.

2.09 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Division 31 Section, Earth Moving, for excavating, trenching, and backfilling.

3.02 CONNECTION

- A. Install unions downstream of all threaded valves and in all locations that supply serviceable equipment.
- B. Screwed Joints: Make joint with clean, full cut standard pipe threads. Ream after cutting and threading. Use heavy duty Teflon sealing compound or Teflon tape as threaded seal. Sealing compound shall be AGA and NSF certified, non-toxic, non-drying, anti-seize, and classified by UL.
- C. Use anti-seize compound on all bolts for flanges.

- D. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).
- E. Press type pipe joints shall be made in accordance with manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fittings alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the manufacturer's approved tool.

3.03 INSTALLATION

- A. For buried water service, clamp water pipe at fittings with 3/4 inch rods and properly anchor and support.
- B. Provide in-line strainer upstream of trap primers. Supply line to trap primers shall be taken off top of domestic cold water main, per manufacturer's recommendations.
- C. Provide a pressure gauge on each side of balancing valves on domestic hot water return loops.
- D. Provide backflow preventer certification documentation prior to final acceptance of system.
- E. No pulled tees (T-drill) are allowed.
- F. Directly downstream from the water heater a thermowell shall be provided for a temperature sensor which will be provided by Division 23 DDC. The temperature sensor shall send an alarm signal to the DDC when the system temperature decreases lower than 130 degrees F.
- G. Directly downstream from the hot water return circulation pump a thermowell shall be provided for a temperature sensor which will be provided by Division 23 DDC. The temperature sensor shall control the on/off function of the pump. The pump shall cut on when the temperature decreases to 130 degrees F. The pump shall cut off when the system temperature reaches 140 degrees F. There shall be an override (timer) by the DDC system which will cut off the pump during nighttime hours from 10pm to 4am, unless there is a demand on the system.
- H. On the domestic cold water supply to the building a thermowell shall be provided to receive a pressure sensor by Division 23 DDC. The pressure sensor shall alarm when the building pressure drops below a pressure setting. Refer to plumbing drawings for location of the sensor.

3.04 DRAINAGE

- A. Install water piping systems with uniform horizontal grade of 1/8 inch per 10 feet, minimum, to low points to provide complete drainage of the system. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain.

3.05 IDENTIFICATION

- A. Identify system components. Comply with requirements in Section 22 05 53.4, Identification for Plumbing Piping and Equipment, for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. 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.
 3. 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.
 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 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 for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.07 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to an accredited laboratory. Repeat procedures if biological examination shows contamination. All results are to be provided to the owner.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

SECTION 22 1119 DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installation of plumbing specialties including the following:
 - 1. Pressure and temperature taps.
 - 2. Automatic air vents.
 - 3. Pressure gauges.
 - 4. Thermometers.
- B. Section 22 11 16 - Domestic Water Piping Systems.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. 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

2.01 MANUFACTURERS

- A. Pressure and Temperature Tap: Subject to compliance with requirements, provide products by Peterson Engineering Company, or Sisco.
- B. Automatic Air Vents: Subject to compliance with requirements provide cast iron body with stainless steel seat and float as manufactured by one of the following:
 - 1. Apco.
 - 2. Armstrong.
 - 3. Clark.
 - 4. ITT Bell & Gosset.
 - 5. Taco.

2.02 PRESSURE AND TEMPERATURE TAPS

- A. Location: Provide pressure and temperature taps where indicated on plumbing drawings and details.
- B. Taps: Provide ½ inch solid brass fittings which will receive either a pressure or temperature probe with valve core of Nordel and fitted with a color coded cap and gasket. Furnish "pete's Plug" as manufactured by Peterson Engineering Company, or "Sisco P/T Plug" as manufactured by Sisco, No. 710, rated at 275°F and 1000 psig. Provide long stem type for insulated pipe.
- C. Instruments: Provide two No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes, and four 5 inch stem pocket thermometers. Two thermometers for domestic hot water systems when applicable. "Pete's plugs" to match insulation thickness.

2.03 WATER SYSTEM AIR VENTS

- A. Furnish and install cast iron body fixed pivot ball automatic float-type air vents at high points of all hydronic systems and where shown on Drawings.
 - 1. Cast iron vent body with stainless steel float, and stainless steel seat, valve and lever.

2. Rate vent for a minimum 125 psi, 400°F.
- B. Extend 1/2-inch copper discharge drain to nearest floor or hub drain.
- C. Ball Valve: Place between air vent and piping system.
 1. 600 pound w.o.g., full port two-piece ball valve with stainless steel ball, reinforced seat, blowout proof stainless steel stem and lever handle, similar to Nibco T-585-70-66LF.

2.04 GAUGES AND THERMOMETERS:

- A. General. Provide gauges and thermometers for monitoring plumbing systems as shown on the drawings and specified herein.
- B. Gauges. Gauges shall be Ashcroft, Trerice, Weksler, Moeller, or U.S. with 4-1/2" dial face, phenol case, stainless steel movement with Grade A phosphor bronze bourdon tube and micrometer-type calibration adjustment screw. Accuracy shall be 1/2 of 1% of full scale. Provide a Crane No. 222H or needle valve with snubbers at the pumps. Provide liquid filled gauges at pumps. Gradation shall be one pound or less.
- C. Thermometers. Thermometers shall be Weksler, Marshall Town or Ashcroft with 5" dial, all stainless steel construction bi-metal type with accuracy of +/- 1% of scale range. Minimum of 2-1/2" straight or angle form stem as best suited for reading. Stem length shall be sized to provide most accurate reading for pipe diameter.
- D. Thermometer Wells. Thermometer wells shall be brass or stainless steel with pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2" lagging protrusion. Locate thermometer wells so the sensing bulb will give a true and correct reading. Install thermometer so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well. All wells shall be filled with silicon and complete with caps and chains.
- E. Range and Gradations. Gauges and thermometers shall be selected to give range and gradations best suited for quantities to be measured. Generally, gauges and thermometers shall be selected so that normal operating pressures and temperatures are not more than 2/3 nor less than 1/2 of the range; scale division shall be 1°F. Typical ranges for domestic cold water and shall be 0° to 100°F and for domestic hot water shall be 30°F to 240°F.
- F. Gauge Locations. Provide pressure gauges at the following locations:
 1. Suction side of each pump (except sump pumps and sewage ejectors).
 2. Discharge side of each pump (except sump pumps and sewage ejectors).
 3. At the main domestic service entry.
 4. At the top of the main domestic water risers.
- G. Thermometer Locations. Provide thermometers and thermometer wells at the following locations:
 1. On each hot water circulating loop return line from the building (locate near circulating pump).
 2. On each incoming cold water supply to each domestic water heater.
 3. On the outlet hot water from the domestic water heater.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Section 22 05 00, Common Work Results for Plumbing, for piping joining materials, joint construction, and basic installation requirements.
- B. Install hydronic specialty items as shown on Drawings and in accordance with manufacturer's installation requirements.
- C. Provide automatic air vents at all high points in systems. For air vents above ceilings and concealed areas, provide copper vent tubing to nearest hub or floor drain.

- D. For strainers, provide valve connection piped to floor drain at all pumps. On strainers that are not piped to drain, provide valved connection with hose adapter and cap.
- E. Provide valved manual air vent where indicated on Drawings. Install pipe plug in valve.

END OF SECTION

SECTION 22 1316 SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installing sanitary waste, soil waste system piping and associated vent piping within buildings and underground laterals within 5 feet of building.

1.02 RELATED WORK

- A. Section 22 05 00 - Common Work Results for Plumbing.
- B. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- C. Section 22 05 29 - Hangers and Supports for Plumbing and Equipment.

1.03 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.

1.04 SUBMITTALS

- A. Field quality-control inspection and test reports.

1.05 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Underground Piping and Piping in Crawl Space: Type 1 Schedule 40 PVC pipe (solid core) conforming to ASTM D-1784, ASTM D-2321 & ASTM D-2665 with DWV pattern fittings with solvent cement joints.
- B. Above Grade Piping, excluding crawl space:
 - 1. Service weight cast iron no-hub soil pipe and DWV pattern fittings. The cast iron soil pipe and fittings shall be manufactured to ASTM A888, ASTM A74 and CISPI 301 (including Annex A). Cast iron soil pipe shall be listed with an ANSI Accredited Testing Agency for quality assurance, and include CISPI Trademark or NSF Trademark stamped or imprinted on the pipe. Manufactured by Charlotte, Tyler or AB & I.
 - 2. Heavy duty shielded stainless steel couplings and tightening devices, ASTM C564 rubber sleeve.
 - 3. 4-band no-hub couplings for pipe sizes 4 inches and less. 6-band no-hub couplings for pipe sizes over 4 inches.
 - 4. Couplings manufactured by Anaco "Husky" SD4000, Ideal Tridon HD or Clamp-All 125.
- C. Piping through Wall Sleeves: Provide section of ductile iron piping, as detailed, in wall penetrations.
- D. The p-trap for the floor drains receiving condensate shall be schedule 40 PVC with solvent cement joints, the remaining portion of the condensate drainage system shall be as specified in paragraph 2.01B & C herein.

2.02 VENT PIPE AND FITTINGS

- A. Vent pipe, fittings, joints and couplings shall be same as specified for the gravity sanitary sewer system as specified herein.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Section 22 05 00, Common Work Results for Plumbing.
- B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Section 22 05 00, Common Work Results for Plumbing.
- C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Section 22 05 00, Common Work Results for Plumbing.
- D. 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." Install PVC piping system per manufacturer's recommendations.
- E. 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 2 fixtures are installed back to back or side by side with common drainpipe. 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.
- F. Vent Connections: Make vent connections to vent stacks with inverted wye fittings. Extend full-size vents through roof to at least 6 inches above roof.
- G. Flashing: Provide flashing as recommended by roofing material manufacturer and detailed by Architect/Engineer.
- H. Cleanouts:
 - 1. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed. No cleanout should be larger than 4 inches in diameter.
 - 2. Where cleanouts occur in pipe chases, bring cleanouts through walls and install covers. Where cleanouts occur in floor slabs, set flush.
 - 3. Provide cleanouts where soil lines change every direction, every 50 feet on long runs, at end of each continuous waste line, and at the base of each riser.
- I. Floor Drains: Locate floor drains 1/2 inch below finish floor elevation unless shown otherwise.
- J. Slope sanitary waste piping at a uniform slope of 1/8" per foot for pipes sizes 3-inch and larger and 1/4" per foot for pipe sizes less than 3-inch. Slope vent piping at a uniform 1/8" per foot slope with the high point at the roof penetration, sloping back down toward the plumbing fixture. Refer to the plumbing code.
- K. Provide joint restraints on cast iron piping for pipe sizes over 4" and in changes in pipe diameter by two pipe sizes or more, and indicated in IPC Section 308, and conforming to CISPI 301-09. Joint restraints shall be Holdrite #117, or approved equal, or as shown on the Plumbing drawings.

3.02 UNDERGROUND PIPING INSTALLATION

- A. General: Install as indicated herein for buried pipe.
- B. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of work to comply with Drawings.
- C. Trench:
 - 1. Excavate trench to depth required.
 - 2. Properly brace and dewater trench and keep it free of water during installation, testing of pipe, and backfilling.

3. Do not discharge water onto a street or freeway without prior approval from Owner's Representative.
- D. Excavation:
1. Trench shall be at least 18 inches wider than the maximum diameter of the pipe or largest bell and laid in the center of the trench.
 2. Excavate trench to a minimum depth of 12" below the bottom of the final elevation of the pipe.
 3. Increase trench width as required and piling left in place until sufficient compacted backfill is in place.
 4. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill.
 5. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc.
 6. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price.
 7. Refer to Structural and Civil drawings for trench details.
- E. Grading:
1. Upon Completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion as per Division 31, except where the cushion has been eliminated by the Engineer.
 2. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion shall be as follows:
 - a. Stable, Firm Semidry Trench: Piping shall be laid on bedding of washed sand with minimum 3 inches thick all around pipe and covering pipe.
 - b. Undisturbed earth, in a constant uniformly sloped trench shall be under the sand bed.
 - c. Laying space for hubs or mechanical joints shall be hand cut to 6 inches either side of the joint and stabilized sand poured and wet in to even with the natural earth trench bottom.
 - d. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping.
 - e. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test being performed again.
 - f. Where the slope of the trench is found to belly down along the line of piping, before joining, the pipe shall be removed from the trench and the belly converted to uniform slope by adding stabilized bank sand, wet down and slightly mounded to the center of the trench. The section of piping will then be "rolled" into place so with support uniform along its entire length.
 - g. Where the slope of the trench is found to arch up along the line of piping, before joining, the pipe shall be removed from the trench and the arch converted to uniform slope by cutting the arch out. The section of piping will then be reset into place with support uniform along its entire length.
 3. Wet Clay (Black Gumbo): Lay piping in a constant, uniformly sloped trench. After shaping, the trench shall receive 6 inch minimum clean bedding sand, which shall be uniformly distributed on the trench bottom.
 - a. Hand remove laying space for the hubs or mechanical joints and place the piping on the setting bed with the weight of the piping distributed evenly on the setting bed over its entire length.
 - b. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping by the Engineer's agent. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test performed again.

4. Rock: Where rock is encountered, the excavate trench to a minimum of 6 inches below the pipe elevation and backfill with bedding sand to provide a uniform layer for pipe support. Backfill shall be as indicated for Wet Clay- Black Gumbo.
- F. Special Considerations: Where there are expansive soil conditions on the site, special precautions shall be taken to prevent pushing and breakage of underground piping. Precautions shall be in accordance with local installation techniques and may include carton forms or special pipe bedding.
- G. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by the Owner Representative.
 1. Place backfill material in the trench either by hand or approved mechanical methods. The compaction of backfill material shall be accompanied by tamping with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three
 2. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect.
 3. Backfill completely around pipe, including 18 inches above the pipe, with suitable bank sand, tamped in 4 inch layers under, around, and over pipe. Water down backfill as required.
 4. The remainder of the backfill for pipes shall be select backfill material tamped at intervals of no more than 12 inch depths, to attain a 95 percent Proctor Compaction Density:
 - a. All materials to be used as select material backfill shall be approved by the Architect.
 - b. If, in the opinion of the Architect, the excavated material does not meet the requirements of select material, the Contractor shall be required to screen the material prior to use as select material backfill.
 - c. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than 6 inches in longest dimension. No wood, vegetable matter, or other material, which in the opinion of the Architect is unsuitable, shall be included in the backfill.
 - d. The upper 24 inches of backfill may be water jetted, if desired. Bring backfill up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation. When removal of unsuitable, excavated material creates a shortage of backfill material, the Contractor shall, at no change in Contract amount, furnish material as specified in this Section in the amount required to complete the backfill.
- H. Existing Surfaces: Restore existing streets, driveways and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Architect.
- I. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the local AHJ. Refer Division 1 for additional requirements.
- J. Underground Piping under Slabs with Carton Forms
 1. Refer to the Geotechnical Engineer recommendations for this project for excavation and remediation of expansive soils and installation of piping below the slab on carton forms.

3.03 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Section 22 05 00, Common Work Results for Plumbing.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.04 VALVE INSTALLATION

- A. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 - 1. Use gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Use gate valve for piping NPS 2-1/2 and larger.
- B. Check Valves: Install swing check valve, downstream from shutoff valve, on each submersible pump discharge.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - 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.
- B. Install supports according to Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. 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. NPS 6: 60 inches with 3/4 inch rod.
 - 5. Spacing for 10 foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8 inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8 inch rod.
 - 3. NPS 2: 10 feet with 3/8 inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2 inch rod.
 - 5. NPS 3: 12 feet with 1/2 inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8 inch rod.
 - 7. NPS 6: 12 feet with 3/4 inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- J. Support PVC piping with maximum hanger spacing per manufacturer's recommendations

3.06 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

- B. Where PVC pipe connects to cast iron piping use transition type no-hub coupling. Provide heavy duty shield type transition coupling specifically designed for cast iron to PVC pipe material changes, similar to Heavy Duty Shielded Transition couplings by Anaco Husky or approved equal, conforming to ASTM C1460, ASTM C564 and meets CSA B602. Coupling shall have 304 stainless steel clamp, screw and shield with ASTM C564 gasket material.

3.07 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. Test pipe before backfilling and connecting to sewers by maintaining not less than 10 feet of hydrostatic head for 4 hours without a leak.
 - 2. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 3. 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.
 - 1. After all sections of soil, waste, and vent piping are installed, but before fixtures are connected, test system by plugging all outlets and filling vertical sections with water to maintain not less than 10 feet of hydrostatic head for 4 hours without any drop in water level for all sections of piping. Provide wyes as required to facilitate plugging.
 - 2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 3. Prepare reports for tests and required corrective action.

3.08 CLEANING

- 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.

END OF SECTION

SECTION 22 1319 SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Drains.
 - 2. Hydrants.
 - 3. Cleanouts.

1.02 RELATED WORK

- A. Section 22 05 00 – Common Work Results for Plumbing.
- B. Section 22 13 16 – Sanitary Waste and Vent Piping.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.04 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, except special custom trench drains which shall be only the specified manufacturer:
 - 1. Wade
 - 2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 3. Josam
 - 4. Zurn Plumbing Products Group; Specification Drainage Operation.

2.02 DRAINS

- A. Design of drains is based on model numbers manufactured by Wade, unless otherwise indicated. Subject to compliance with requirements, provide named product or comparable product by one of the listed acceptable manufacturers:
 - 1. Floor Drains (FD-1): Wade No. 1100-G6-1, cast iron floor drain with flashing collar, seepage flange, nickel bronze 6 inch square adjustable strainer with square holes.
 - 2. Floor Drains (FD-2): Wade No. 2140-12-27-39, galvanized cast iron floor drain with flange, 8 inch square top, full galvanized cast iron grate, with aluminum sediment bucket.
 - 3. Floor Sink (FS-1): Wade No. 9150-1-15-24-26-48, cast iron 12 inch square floor sink with 10 inch sump, acid resistant porcelain interior, aluminum dome interior strainer, 1/2 nickel bronze grate, with clamping device.
 - 4. Floor Sink (FS-2): Wade No. 9200-1-15-26, cast iron 4" x 8" floor sink with acid resistant porcelain interior, aluminum dome interior strainer, 1/2 nickel bronze grate with clamping device.

2.03 CLEANOUTS

- A. Location:
 - 1. Provide drainage lines with properly specified cleanouts.
 - 2. Locate cleanouts in runs not more than 90 feet on centers or as required by local authority having jurisdiction.
 - 3. Provide cleanouts at the base of each soil or waste stack and wherever necessary to make accessible all parts of the drainage soil or waste systems, whether or not indicated on drawings.

4. Extend cleanouts within chases to near wall and provide wall access cover compatible with wall construction.
 5. Provide cleanouts of required size, with flashing flange where installed with membrane waterproofing.
- B. Finished and Unfinished Walls. Wade No. 8303-85-VP-75, duracoated, cast iron cleanout with cast bronze plug and square polished stainless steel wall cleanout access panel with secured smooth cover and frame with anchor lugs.
- C. Floor Cleanouts. Wade No. 6000-1-75, painted cast iron floor cleanout with anchor flange, adjustable top, secured scoriated cover, adjustable threaded bronze plug, and satin finish nickel bronze cover.
- D. Exposed Piping. Wade No. 8550-75, cast iron calk ferrule and cast bronze plug with ½" NPT test port with raised head plug and internal threading for test plug use.
- E. Outside Area. Wade No. 6000-12-75, painted cast iron floor cleanout with anchor flange, adjustable top, secured scoriated cover, adjustable threaded bronze plug, cast flush in a 16 inch x 16 inch x 6 inch thick concrete pad in nonsurfaced areas.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Section 22 05 00, Common Work Results for Plumbing, for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in above ground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For 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 or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 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 deep-seal traps on floor drains and other waste outlets, if indicated.
- F. 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.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

- H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

3.02 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.

3.03 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 Section 22 05 53.4, Identification for Plumbing Piping and Equipment.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 4000 PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Sinks.
 - 2. Lab Sink Faucets
 - 3. Emergency Shower Units
 - 4. Emergency Eyewash Units
- B. Related Sections include the following:
 - 1. Section 22 11 16 - Domestic Water Piping.
 - 2. Section 22 05 00 - Common Work Results for Plumbing.
 - 3. Section 22 13 16 - Sanitary Waste and Vent Piping.

1.02 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistant qualities.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

1.04 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. 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.
- C. Regulatory Requirements:
 - 1. Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
 - 2. Comply with requirements in Texas Senate Bill 587 for requirements about minimum water conservation performance requirements.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components—Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. 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 Residential Sinks: ASME A112.19.3.
 5. Vitreous-China Fixtures: ASME A112.19.2M.
 6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 7. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- G. 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.
- H. 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.
- I. 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. Grab Bars: ASTM F 446.
 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 Toilet Seats: ANSI Z124.5.
 9. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers.
- B. Lavatory & Sink Faucets:
1. Chicago Faucets.
 2. Symmons Industries, Inc.
 3. Moen.
 4. T&S Brass.
 5. Speakman.
 6. Sloan
 7. Delta Commercial.

- C. Stainless Steel Sinks:
 - 1. Just Manufacturing Co.
 - 2. Elkay Manufacturing Co.
 - 3. Moen, Inc.
 - 4. Griffin
 - 5. Advance Tabco
- D. Sink Trim (Supplies, Traps, Strainers):
 - 1. McGuire
 - 2. Elkay Manufacturing Co.
 - 3. Chicago Faucets.
 - 4. T&S Brass & Bronze Works, Inc.
 - 5. Kohler Co.
- E. Emergency Showers:
 - 1. Haws.
 - 2. Guardian.
 - 3. Bradley.
 - 4. Acorn Safety
- F. Plumbing Fixture Carriers
 - 1. Wade
 - 2. Zurn
 - 3. Jay R. Smith
 - 4. Josam

2.02 LAB SINKS

- A. Specified in Specification Section 12 35 53.13.
 - 1. Bowl: Refer to Architectural drawings.
 - 2. Faucet: Provided by Lab Casework Supplier and specified in Division 12.
 - 3. Supplies: McGuire No. LF2165-LK supply, escutcheon, 3/8" x 12" flexible tube riser and loose key control angle stop, all with chrome finish. Compression connections are not allowed.
 - 4. P-Trap: Fixture traps for all laboratory sinks and cup sinks (including fume hood cup sinks) shall be point of use dilution traps similar to Zurn Z90-PHIX, with polypropylene body, 1 1/2" compression inlet and no-hub outlet, removable neutralizing chamber, and lower sediment collection chamber, with flow rate of 8 GPM.
 - 5. Emergency Eyewash Unit (Where indicated on the" drawings).
 - 6. Provide sink strainer to insert into each cast epoxy resin sink and stainless steel sinks (not stainless steel hand wash sinks) specified in spec section 123553.13. Strainer fit into sink drain outlet and shall be removable, class 27 stainless steel mesh, similar to LabScientific Supplies and Equipment Model No. DP40C and DP60C (provide specific model for size of drain outlet), or approved equal. Coordinate model with sinks specified in section 123553.13 and the location shown on the "A800" drawings.
 - 7. Where shown on plumbing plans with hot water connections: Provide ASSE 1070 compliant thermostatic mixing valve with maximum outlet temperature of 120 degrees F, as specified in spec. section 22 11 16.
- B. Cup Sink Traps:
 - 1. Fixture traps for all laboratory sinks and cup sinks (including fume hood cup sinks) shall be point of use dilution traps similar to Zurn Z90-PHIX, with polypropylene body, 1 1/2" compression inlet and no-hub outlet, removable neutralizing chamber, and lower sediment collection chamber, with flow rate of 8 GPM.

2.03 FIXTURE CARRIERS

- A. Water Closet Carriers: Wade 310, 330 & 340 Series or approved equal.

1. Adjustable heavy duty (for extra heavy weight support - minimum 500 lbs. capacity by independent testing lab) cast iron horizontal or vertical integral carrier fitting with neoprene faceplate gasket and anchoring feet, complete with rear anchor support.
- B. Urinal Carriers: Wade 400 Series or approved equal.
 1. Free standing concealed chair carrier with rectangular steel uprights, support studs, bearing plate and anchoring feet plate.
- C. Lavatory Carriers: Wade 520 or approved equal.
 1. Free-standing adjustable for concealed arms, steel uprights, bearing plate and anchoring feet plate, ductile iron arms, invertible headers.

2.04 ROUGH-IN BOX

- A. Rough-in Box (RB-1): Furnish and install hook-up box, constructed of 20 gauge steel, recessed, painted to match wall, with 1/2" chrome plated angle valve, manufactured by Guy Gray No. BIM875, with 5-micron cartridge type filter and housing to be installed between angle valve and equipment. Mount top of box at 15" above finished floor.

2.05 WATER HAMMER ARRESTORS

- A. Provide hydraulic shock absorbers in cold and hot water supply lines to each individual plumbing fixture or battery of fixtures, and at each automatic, solenoid-operated or quick-closing valve serving mechanical, kitchen or laundry equipment. Shock arrestors shall be of seamless type "K" copper body construction or type 304 stainless steel body with stainless steel bellows, nitrogen and helium gas pre-charged. Shock arrestor shall be certified to ASSE 1010-2004 Standard and listed with IAPMO, completely sealed and operating free of casing. Size all units according to water hammer arresters standard PDI-WH-201. The shock arrestor shall have a lifetime warranty and shall be designed to provide continuous protection without maintenance allowing the shock arrestor to be installed without an access panel. Manufactured by Sioux Chief "Hydra-Rester", Mi-Fab, Jay R. Smith and FNW.

2.06 EMERGENCY SAFETY EQUIPMENT

- A. Combination Emergency Shower/Eyewash (ES-1): Barrier Free swing down eye-face wash and shower actuation valve in stainless steel cabinet for recessed mounting with 2 swing down eyewash spray heads, self regulating flow control, stainless steel actuating arm with stainless steel ceiling recessed shower head, ANSI Z358.1 compliant, with 2 inch drain with stainless steel drain pan, manufactured by Guardian Equipment GBF2350, or approved equal.
- B. (EW-1) – Deck mounted swivel eyewash mounted on counter next to sink with flag handle activation, chrome plated brass fixture, ADA compliant, flip top dust covers, internal flow control and filter, 90 degree swivel operation, chrome plated brass stay-open ball valve, furnished with universal identification sign (WaterSaver AP3600 or equal).

PART 3 EXECUTION

3.01 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.
- 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.

- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment, unless sensor operated. Install other actuators in locations that are easy for people with disabilities to reach.
- I. Install toilet seats on water closets.
- J. 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.
- K. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- L. 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.
- M. Install traps on fixture outlets:
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- N. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Section 22 05 00.4, Common Work Results for Plumbing.
- O. Refer to Architectural drawings for fixture mounting heights.
- P. Provide an ASSE 1070 compliant thermostatic mixing valve on the domestic hot water and cold water supply piping serving break room sinks, hand wash sinks and lavatories, and where shown on the drawings.

3.02 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.
- C. Ground equipment according to Division 26 requirements.
- D. The installation of rough-ins and carriers of water closets shall be inspected by Owner and/or Engineer prior to coverup. The supports/carriers for water closets shall be securely anchored to the floor and shall be heavy weight type carriers, rated to support a minimum of 500 lbs.
- E. For sinks not indicated to be provided by Division 22, provide the same supply stops as specified for sinks herein. Compression connections are not allowed.
- F. Install shock arrestors on pipe headers for fixture groups in locations shown on plumbing riser diagrams and as recommended by the manufacturer. Domestic water supplies to single plumbing fixtures shall be provided with shock arrestors. The use of only air chambers as shock protection is not allowed.

3.03 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.

3.04 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.

END OF SECTION

SECTION 22 6119 COMPRESSED AIR SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Provide compressed air piping, valves, fittings, regulators etc., for connection to the existing compressed air system in the building. For the systems rough-in and make final connection of piping system to lab outlets, fume hoods, overhead service carriers, service fittings, etc. where indicated on the Plumbing floor plans and Lab Casework Drawings. Provide and install all piping, fittings, valves, etc. for a complete operational laboratory compressed air system. This Section includes requirements for compressed air systems and the following accessories:
 - 1. Regulators.
 - 2. Valves.
 - 3. Pipe and fittings.

1.02 RELATED SECTIONS

- A. Section 22 05 00 - Common Work Results for Plumbing.
- B. Section 22 05 26 - Pipe and Fittings.
- C. Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment.
- D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.
- C. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is an NRTL and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- 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 NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories where designated for laboratory air systems and medical compressed air systems.

1.05 DELIVERY STORAGE AND HANDLING

- A. Deliver pumping systems, controllers, and accessories in factory-fabricated water-resistant wrapping.
- B. Handle pumping systems, controllers, and accessories carefully to avoid damage to materials, components, enclosure, and finish.
- C. Store pumping systems, controllers, and accessories in a clean, dry space and protect from the weather.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ohio Medical
 - 2. Powerex.
 - 3. Amico.

4. Beacon Medaes.
5. Domnick Hunter.
6. Airtech.
7. Arrow.
8. Atlas Copco.
9. Zander.
10. Ingersall Rand
11. Champion
12. Nano
13. Patton's Medical

2.02 REGULATORS

- A. Compressed Air System Serving the Lab Areas: Zinc die cast body, diaphragm-operated, direct-acting, spring-load, manual pressure setting adjustment, Nitrile seals, complete with 0-160 psi pressure gauge, rated for a maximum of 300 psi inlet pressure, gauge ports, adjustable pressure range of 0 to 180 psig, manufactured by Wilkerson Model R30-XX-G00, or approved equal.

2.03 PIPE AND FITTINGS

- A. Compressed Air System Serving the Lab Areas (CA & LA): Hard drawn Type "L" copper pipe, conforming to ASTM B819, factory prepared for oxygen service, as specified herein. Fittings shall be seamless wrought copper, socket joint, ANSI B16.22. Joints shall be brazed, using nitrogen purge, as specified herein. Brazing alloy shall be NFPA 99C compliant, conforming to BS EN 10044CP. Unions shall be wrought copper with metal to metal seats.

2.04 GAUGES

- A. Bourbon tube type, with stainless steel spring, suspended movement, 316 stainless steel bourbon tube, with minimum 2-1/2 inch dial, shatterproof glass window with stainless steel case, 1/4 inch NPT brass socket connection, 1 percent full scale accuracy and shall be made in accordance with ASME 40.1 grade 1A, scale range 0-160 psi, Figure intervals at 20 psi, and minor divisions at 2 psi increments, manufactured by Terice No. 700 series, or approved equal.

2.05 UNIONS

- A. Provide Class 150, 300-pound water-oil-gas service wrought solder joint fitting, such as Nibco 633/733 union C x C, or approved equal, ANSI B16.22. Flange joints larger than 2 inches shall be brass. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.

2.06 VALVES

- A. 3-piece bronze ball valve with extended copper tube ends, 316 stainless ball and stem, 600 WOG, full port, in-line repairable, RPTFE seats, blow out proof stem, manufactured by Milwaukee No. BA350S-TE or approved equal.

2.07 PIPE SUPPORTS

- A. Refer to Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and capped or that are furnished unsuitable for laboratory air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service." Tape is not an acceptable sealing method.
- B. Ream pipe and tube ends full pipe bore. Remove burrs. Bevel plain end ferrous pipe. Remove scale dirt on inside and outside before assembly. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Route piping in orderly manner and maintain gradient.
- B. Install piping to conserve building space and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- F. Protect piping systems from entry of foreign materials by temporary caps, completing sections of the work, and isolating parts of completed system.
- G. Contractor is responsible for complying with all state and local regulations

3.03 CONNECTIONS

- A. Comply with requirements for water-supply piping specified in Section 22 11 16, Domestic Water Piping Systems. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for drain piping specified in Section 22 13 16, Sanitary Waste and Vent Piping. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Connect compressed air piping to compressed air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.04 IDENTIFICATION

- A. Identify compressed-air equipment system components. Comply with requirements for identification specified in Section 22 05 53, Identification for Plumbing Piping and Equipment and NFPA 99. The compressed air system shall have piping, fittings and valves identified as lab air use, and lab equipment use.

3.05 FIELD QUALITY CONTROL FOR COMPRESSED AIR SYSTEMS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Compressed Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of compressed-air equipment concurrently with tests, inspections, and certification of compressed air piping and laboratory gas piping systems.
 - 2. Preparation: For the Lab Air System perform compressed air equipment tests according to requirements in NFPA 99 for the following:
 - a. Air quality purity test.
 - b. System operation test.
 - 3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of compressed air equipment.
 - 4. Replace damaged and malfunctioning controls and equipment.
 - 5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.

- c. Test methods used.
 - d. Results of tests.
- E. Components will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Follow NFPA 99 guidelines and requirements for the compressed lab air system. All the compressed lab air systems does not need to be third party certified, but shall comply with the requirements and guidelines of NFPA 99 as it shown and specified.
- H. Installers for the compressed lab air system shall be certified in medical gas piping systems installations.

END OF SECTION

**SECTION 23 0010
MECHANICAL GENERAL PROVISIONS**

PART 1 GENERAL

1.01 SUMMARY

- A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.
- B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.
- C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements, and provide coordination drawings.
- D. All work in these Sections shall be installed by craftsmen skilled in their trade.
- E. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 019000, General Commissioning, for detailed commissioning requirements.

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. Install: The term "install" is used to describe operations at project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.

1.03 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
- B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. Obtain and pay for all permits and inspections.
- D. The following building codes are applicable to this project.
 - 1. 2021 International Mechanical Code

2. 2021 International Building Code
3. 2018 International Energy Conservation Code
4. State Energy Conservation Office (SECO) mandated state building compliance with ASHRAE 90.1-2013

1.04 REFERENCES

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.
- B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.05 SUBMITTALS

- A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
 1. Proper sizes and capacities.
 2. That the item will fit in the available space in a manner that will allow proper service.
 3. Construction methods, materials, and finishes.
- B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
- D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.
- E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.
- F. Refer to Section 01 33 00 for additional submittal requirements.

1.06 COORDINATION DRAWINGS

- A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building. The Contractor shall submit the coordination drawing for confirmation of the coordination process. The Contractor is responsible for all trade confirmation.
- B. CAD. Provide 1/4 inch scale 3D coordination drawings.
 1. Drawings shall show all equipment, ductwork, cable trays, fire protection system, coil pull spaces, chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room to verify space allocation and coordination of trades.
 2. Provide plan and elevation views detailing installation.

3. Drawings shall include 1/4 inch scale drawing of each mechanical room. Drawing shall show coil pull spaces and coordination of all ductwork, all chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room. Provide plan and elevation views detailing installation
4. Contractor may not proceed with construction of MEP systems until trade coordination process has been demonstrated to be completed by the Contractor to the Architect, Engineer and Owner.

1.07 INTERFERENCE DRAWINGS

- A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor's proposed solution.
- B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.08 GUARANTEE

- A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.

1.09 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer's recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.10 RESOLUTION OF CONFLICTS

- A. Where conflicts may exist between and/or within the drawings and/or specifications, the higher quality, greater quantity, more restrictive, and/or more expensive requirement shall be required and shall be the basis of Contractor pricing. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.
- B. Manufacturers' names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.
- C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers' list will be acceptable on approval.
- D. Substitutions:
 1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/ Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.

2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
 3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
 4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
 5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
 6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
 7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.
 8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.
- E. Basis of Design: Where a basis of design is indicated (i.e., scheduled products), that product was used for the purposes of established space requirements, structural design for the building, utility connections, etc. If the contractor elects to furnish a product other than the basis of design product (either another named acceptable manufacturer or via substitution) the contractor is responsible for any construction or design costs associated with the non-basis of design product.

2.03 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.
- B. Seal all wall and partition penetrations (the penetration opening shall be one inch larger than penetrating member) by ducts and piping by stuffing the annular void with fiberglass insulation and then caulking over fully with a non hardening acoustical caulking applied to both sides of wall or partition.

2.04 AIR FILTERS AND PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service hydronic system strainers and replace disposable type air filters.
- B. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.05 ACCESS DOORS

- A. Provide access doors for all walls or ceiling locations as required for access to valves, controls, regulating devices, water arresters, fire dampers, air distribution boxes, and other concealed equipment requiring maintenance adjustment or operation. Coordinate location with General Contractor.
- B. Refer to architectural Sections for access door requirements.

2.06 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.
- B. Workmanship: Work must be performed by workmen skilled in their trade.
- C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer's recommendations.
- D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.02 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
 - 1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
 - 2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
 - 3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.
 - 4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.
 - 5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.
 - 6. Install domestic hot and cold water in the plane directly above the light fixtures.
 - 7. Refer to Division 26 for electrical and control wiring requirements.
 - 8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.03 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.

- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.04 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.05 ACCESS DOORS

- A. Coordinate location of access doors for ease of operation and maintenance of concealed equipment.

3.06 DELIVERY, STORAGE AND HANDLING

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.
- C. At work completion, all work must be clean and in like new condition.
- D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with the manufacturer's written installation instructions.
- E. Rotate air handler fans and pump shafts on routine basis.
- F. Provide factory installed pipe caps for all pipes to be installed on the project.
- G. Provide covers over all openings in ductwork stored or installed on the project.
- H. Energize motor heaters with temporary power as soon as the motor is received on site.
- I. Air Handling Units shall not be used as storage containers.

3.07 LUBRICATION AND OIL

- A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.08 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections for Interior Painting and Exterior Painting.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Paint mechanical items located outdoors, in building equipment rooms, in tunnels and on roof. Painting of mechanical systems includes preparing, painting, and color coding work.
- D. Preparation and application shall be in accordance with Division 09 Painting Sections.
- E. Mechanical items to be painted include, but are not limited to, piping, pipe hangers, heat exchangers and tanks, mechanical equipment, insulation, equipment supports, motors, and ductwork.
- F. Thoroughly clean surfaces receiving paint of dirt, grease, oil, rust, and scale.
- G. Unless otherwise specified, paint using three coats of selected colors. Mix and use exactly as specified by manufacturer. Allow each coat to dry thoroughly before applying succeeding coats. Painting may be done by spraying where feasible.
- H. Upon completion of painting, remove all scaffolds, surplus material, rags, and trash to leave spaces neat and clean.

- I. Machinery and Equipment: Paint motors, compressors, tanks, air handling units, and other similar equipment according to the following requirements:
 - 1. First Coat: Rust inhibitive primer (not required if factory painted). Use galvanized iron primer where applicable.
 - 2. Second Coat: Machinery enamel. Factory finished items require matching touch up only.
 - 3. Third Coat: Machinery enamel.
- J. Piping and Ductwork:
 - 1. First Coat: Rust inhibitive primer. Use galvanized iron primer where applicable. Omit first coat on pre-sized insulated pipe.
 - 2. Second Coat: Enamel.
 - 3. Third Coat: Enamel.
- K. Pipe Coding:
 - 1. Each line shall receive pipe marker as specified.
 - 2. Paint pipe in accordance with the campus's existing painting schedule:

PAINTING SCHEDULE	
Color Code – Finish Coats	
Item	Color
Heating Water Supply	Red
Heating Water Return	Pink
Chilled Water Supply	Dark Blue
Chilled Water Return	Light Blue

3.09 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 - 1. Do not use impact-type equipment except where specifically acceptable to the Architect/Engineer.
 - 2. Core drill openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., to exact size.
- C. Restoration: Restore all openings to "as-new" condition under the appropriate Specification Section for the materials involved
- D. Match remaining surrounding materials and finishes.
- E. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
- F. Provide adequate support during cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- G. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. The following mechanical system items shall be completed prior to requesting the Owner to provide chilled water or hot water from the campus distribution system:
 - 1. All chilled and hot water piping systems must be complete.
 - 2. All hydronic-piping systems must be cleaned in accordance with specifications.
 - 3. All chilled water piping must be insulated and sealed.

4. All pumps, air handlers and other associated equipment must be installed in their permanent location with all valves, strainers, piping, vibration isolation, electrical connections and safety devices in place.
 5. Controls to regulate temperature and water flow must be in place and operational.
 6. Provide and service fine mesh construction inserts in pump strainers.
- B. All permanent filters for air handlers must be in place. Temporary filters must be installed on VFD drives and fan powered VAV boxes during construction. Provide temporary filter media ahead of permanent filters and replace when dirty. Do not operate exhaust devices, including fume hoods, during gypboard finishing.
- C. Factory startup of the VFD drives shall occur prior to turning on units.
- D. A preliminary air balance of the supply air shall be performed within one week of start-up by the TAB firm. All air unit and fan motors amperage ratings shall be measured and provided to the Owner in the preliminary Air Balance Report.
- E. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the Owner prior to submitting a written request for service.
- F. All equipment operated shall be serviced on a regular basis by the contractor.
- G. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.
- H. All warranties will be commenced at the time of final acceptance.

3.11 OPERATING TESTS

- A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, freezestats and alarms.
- C. Make adjustments as required to ensure proper functioning of all systems.
- D. Special tests on individual systems are specified under individual Sections.
- E. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings in accordance with Specification 01 78 23. Detailed requirements for these items are as follows:
1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair and replacement procurement procedures.
 - g. Operating instructions including start up and shutdown procedures.
 - h. Safety considerations including load limits, speed, temperature and pressure.

2. Provide O&M manuals for all HVAC equipment.

3.13 PROJECT RECORD DOCUMENTS

- A. Refer to specification 01 78 39 for requirements.
- B. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
- C. Mark the drawings with a colored pencil.
- D. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.
- E. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.
- F. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.
- G. Delivery of as-built prints and reproducibles is a condition of final acceptance.

3.14 TRAINING

- A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the manufacturer/Contractor to instruct the Owner's Representative and up to 8 members of the Owner's staff in the operation and maintenance of the entire system. Record training sessions on DVDs for instructing future technicians.
- B. Provide training for the following pieces of equipment:

Items:	HRs of Training Pre-Substantial Completion	HRs of Training at 6 months from Substantial Completion	HRs of Training at 11 months from Substantial Completion	Video Taping Required
DDC Controls	16	8	8	X
VFDs	4	4		X
Air Handling Units	4			X
Fans	4			X

- C. All training sessions shall be scheduled in coordination with the Owner's Representative 14 days in advance, attendance taken, and sign-in sheet and training materials included in the O&M manuals. Refer to Section 019113, General Commissioning, for additional contractor training requirements.

END OF SECTION

SECTION 23 0020 MECHANICAL DEMOLITION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Mechanical demolition for remodeling and work within existing buildings.

1.02 RELATED DOCUMENTS

- A. The requirements of the General Conditions, Supplementary Conditions, Division 01, and Drawings apply to all Work herein.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. Section 23 00 10: Mechanical General Provisions

1.03 SCOPE

- A. Existing buildings and their facilities must remain functional while the Work under this Contract is performed. All system shutdowns and outages must be minimized, provided with temporary heating or cooling systems as part of the base bid, and coordinated with the Owner.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: as specified in individual Sections.
- B. Provide all materials necessary for work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. All demolitions or modifications to existing systems shall be coordinated through Owner's Representative. Demolition drawings are based on field observation and existing record documentations. Therefore, the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and routing arrangements are as shown on Drawings and abandoned infrastructure and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.
- B. Beginning of demolition means Contractor accepts existing conditions.

3.02 PREPARATION

- A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal. Provide temporary piping, ductwork and connections to maintain remaining systems in service during demolition and/or modification. Owner reserve the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.
- B. Existing Mechanical Service: Maintain existing systems not scheduled for demolition in operational condition.
- C. Where owner allows existing mechanical systems to be used during demolition and renovation, it is the contractors' responsibility to protect these systems from debris generated by the work process by means of temporary filters and strainers. In addition, at the completion of the project the contractor must repair/replace any damaged equipment and clean the equipment at no cost to the owner. The contractor is responsible for maintaining water treatment in the same or better condition than before the systems were turned over. The contractor is responsible for any treatment required prior to draining piping to prevent corrosion.

3.03 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

A. General:

1. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace, as required, any damage that might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
 2. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap piping with same or compatible piping material.
 - c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
 - d. Ducts to Be Abandoned in Place: Cap ducts with same or compatible ductwork material.
 - e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - h. All piping and ductwork that is not to be reused shall be removed back to the nearest main and capped with similar material.
 3. Where piping or ductwork is removed, repair insulation where existing insulation is damaged or where duct/pipe is capped with new products matching existing insulation.
- B. Loss or Damage: The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all mechanical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.
- C. Operational Continuity: The Contractor shall provide temporary or new services to all existing facilities and utility streams as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- D. Utility Access: Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.
- E. Demolition of Architectural/Structural Elements: Where partitions, wall, floors, or ceiling of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- F. Scheduled Service Outages: Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two (2) weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, and temporary systems shall be included in the contract amount.

- G. Pre-Demolition Salvage Survey: The Contractor shall modify, remove, and/or relocate all materials and items so indicated or as required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owner's Representative before demolition begins and determine all materials that the Owner specifically chooses to be salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- H. Relocated Equipment: All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- I. Damaged Materials/Equipment to be Reused: When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- J. Termination of Utility Services: Service lines and piping to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as herein above specified.
- K. Nighttime Shifts: Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate times with the Owner.
- L. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the Drawings. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.
- M. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.
- N. Mechanical equipment and building systems equipment, and similar items which are to remain but which are served by piping that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.
- O. Existing registers, grilles, and diffusers shown to be removed and indicated to be reused, shall be cleaned, repaired and provided with such new accessories as may be needed for the proper installation in their new locations.
- P. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing air devices, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.

- Q. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, thermostats, other materials and equipment and their appurtenances shall be removed and relocated if necessary where required by the remodel work either shown or specified.
- R. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- S. Equipment, materials or other potential hazards to the public and working occupants of the building shall not be left overnight outside of the designated working or construction areas.
- T. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner's Representative.
- U. Refer to Architectural Demolition and Alteration plans for actual location of wall, ceiling, and similar items being removed and/or remodeled.
- V. Drawings do not fully indicate conditions or existing obstructions or utilities. Visit the site and examine work to be removed and become familiar with conditions affecting work.
- W. Remove ductwork, piping, controls and equipment including previously abandoned mechanical systems full length from source to device. No re-use of existing materials for new construction is allowed except as specifically outlined in the construction documents.
- X. Maintain access to existing mechanical installations that remain active.
- Y. Within the renovation or alteration areas where existing ceilings are being removed and new ceilings are installed, all new air devices shall be provided.

3.04 DISPOSITION OF MATERIAL AND EQUIPMENT

- A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner's specified location.
- B. For those materials not required by the Owner, dispose of them in accordance with all applicable regulations.

END OF SECTION

**SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes general requirements for 1-phase and 3-phase electric motors with NEMA frame machines sized through 200 horsepower and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation. Unless otherwise specified, provide motors meeting the basic requirements for general purpose alternating current motors, as defined in ANSI/NEMA MG 1-1.05.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

1.03 REFERENCES

- A. ANSI/IEEE 117 - Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random Wound AC Electric Machinery.
- B. ANSI/NEMA MG 1 - Motors and Generators.
- C. ANSI/NEMA MG 2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors.
- D. ANSI/UL 674 - Electric Motors and Generators for Use in Hazardous (Classified) Locations.
- E. ANSI/UL 1004 - Electric Motors.
- F. Energy Conservation Design Standard for New State Buildings.

1.04 SUBMITTALS

- A. Provide the following information for each motor:
 - 1. Manufacturer.
 - 2. Rated full load horsepower.
 - 3. Rated volts.
 - 4. Number of phases.
 - 5. Frequency in hertz.
 - 6. Full load amperes (FLA).
 - 7. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
 - 8. Nominal speed at full load (rpm).
 - 9. Service factor.
 - 10. NEMA design letter.
 - 11. NEMA machine type (ODP, WP-I, TEFC, etc.).
 - 12. Motor space heater voltage, wattage and number of wires (where applicable)
- B. For motors 3/4 horsepower and larger, include the following additional information:
 - 1. NEMA frame size.
 - 2. NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance with the intent of paragraph 2.3C.
 - 3. Maximum ambient temperature for which motor is designed.
 - 4. Time rating.
 - 5. Bearing type.
 - 6. Efficiency at full load.

- C. For motors 20 horsepower and larger, include the following additional information:
 - 1. No load amperes.
 - 2. Efficiency at 1/2 and 3/4 load.
 - 3. Power factor at no load, 1/2, 3/4 and full load.
 - 4. Full load amperes.
 - 5. Maximum guaranteed slip at full load.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements for integral horsepower motors, provide products by one of the following:
 - 1. General Electric.
 - 2. Baldor/Reliance.
 - 3. Toshiba
 - 4. TECO Westinghouse.

2.02 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.03 MOTOR CHARACTERISTICS

- A. Speed and Size:
 - 1. Speed and approximate horsepower ratings are specified in the driven equipment specification Sections or are indicated on the Drawings. 1800 rpm (4 pole) and 3600 rpm (2 pole) motors are acceptable.
 - 2. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity.
 - 3. Size motors so as not to overload at any point throughout the normal operating range.
 - 4. Provide motors designed and rated for variable frequency drive applications where required.
- B. Voltage:
 - 1. Single phase: 115 volts for 120-volt nominal system voltage and 277 volts (refer to mechanical schedules).
 - 2. Three phase: 460 volts for 480-volt nominal system voltage.
- C. Frequency: 60 hertz.
- D. Service Factor: According to NEMA MG 1-12.47 but not less than 1.15.
- E. Acceleration Time: For integral horsepower motors, the calculated acceleration time of the combined motor and driven load shall not exceed 4 seconds at 90 percent of rated voltage.
- F. Efficiency:
 - 1. Provide single-speed NEMA Design B Premium efficiency induction motors having minimal full-load motor efficiency no less than those listed in the latest edition of NEMA MG 1 Section 12.60 (EFFICIENCY LEVEL OF PREMIUM EFFICIENCY ELECTRIC MOTORS). Motors and manufacturers shall be officially listed and labeled by the NEMA Premium program.
 - 2. Base motor efficiencies on a statistically valid control procedure conforming to ANSI/IEEE 112-84, Test Method B (Dynamometer), using NEMA MG 1).
 - 3. For motors rated at a horsepower not listed in the NEMA guidelines, the motors shall conform to the next higher nominal motor horsepower efficiency rating.

2.04 DESIGN TYPE

- A. Motors Smaller than 1/6 Horsepower: Single-phase squirrel-cage induction motors with integral thermal protectors.

- B. Motors 1/6 through 1/2 Horsepower: Single-phase NEMA Design Letter N, squirrel-cage induction motors with integral thermal protectors.
- C. Motors Larger than 1/2 Horsepower: 3-phase, NEMA Design Letter B, squirrel-cage induction motors.
- D. Motor Driven by Variable Frequency Drives (VFDs): Motors driven by VFDs shall be per NEMA MG1, part 31.

2.05 MOTOR INSULATION

- A. Class. Use Class F insulation system meeting the requirements of NEMA MG Part 31 and made of non-hygroscopic materials for motors 10 HP and larger.
- B. Use Class B Temperature Rise: NEMA MG 1-12.41 for fractional horsepower motors and NEMA MG 1-12.42 for integral horsepower motors.
- C. Outdoor Suitability:
 - 1. Where motors must be suitable for outdoor installation, insulation must withstand 1 full week (168 hours) of testing in a chamber maintained at 100 percent relative humidity and 40°C ambient temperature.
 - 2. Immediately after the test period, insulation system must have a minimum resistance of 1.5 megohms.
 - 3. Coat inside circumference of the stator and the outside circumference of the rotor and shaft with the same moisture-resistant insulation system.
- D. VFD Motors: Inverter duty type and capable of withstanding repeated peaks of 1600 volts at 0.1 microsecond rise time. Comply with NEMA MG-1 Part 31.

2.06 LEADS

- A. Use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.
- B. Provide permanent identification numbers on leads according to NEMA MG 1-2.02.
- C. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.

2.07 ENCLOSURE

- A. Indoors:
 - 1. Open drip-proof (ODP).
 - 2. Use steel frame for motors smaller than 3/4 horsepower and up to 1 HP, and cast-iron frame for motors over 1 horsepower.
- B. Outdoors: Completely enclosed, fan cooled (TEFC), with a corrosion-resistant drain plug at the lowest point of the motor for draining. Use cast-iron frame.
- C. Motors 1 HP and greater that are driven by variable frequency drives, provide motor with factory mounted shaft grounding ring. Shaft grounding device shall be accessible for inspection and replacement without disassembling the motor.

2.08 BEARINGS

- A. Motors Smaller than 1/6 Horsepower: Motor manufacturer's standard bearing is acceptable.
- B. Motors 1/6 Horsepower and Larger:
 - 1. Antifriction:
 - a. Supply motors with grease-lubricated antifriction ball bearings conservatively rated for long life under the total radial and thrust loads produced by the actual combination of motor-driven equipment.
 - b. Provide each motor with suitable lubrication fittings and pressure relief devices suitable for in-service lubrication.
 - c. Bearing calculated L10 life must be at least 250,000 hours for direct coupled applications.

2. Oil Lubricated: If the driven equipment Section specifies oil-lubricated bearings for motors, include a suitable sight gauge on each bearing with maximum and minimum levels clearly indicated.

2.09 HARDWARE

- A. Use structural bolts, washers, nuts, pins, and similar items manufactured of high-strength steel. Use only hexagon-head bolts and hexagon nuts.
- B. Use corrosion-resistant materials or protect hardware from corrosion by hot-dip galvanizing, chrome plating, or cadmium plating.

2.10 NAMEPLATES

- A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG 1-10.38, and the National Electrical Code, Section 430-7. Identify energy-efficient motors in accordance with MG-1-12.54.2.
- B. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Indicate bearing data if nonstandard.
- C. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

2.11 CONDUIT BOX

- A. For each motor not supplied with a cord and plug, provide a conduit box suitably sized for the motor lead terminations, in accordance with the National Electrical Code, Section 430-12. Include a grounding lug for motors 1/6 horsepower and larger. Supply a gasket suitable for the motor enclosure type and application.

2.12 PAINT

- A. Manufacturer's standard shop paints for prime and finish coats are acceptable.

2.13 NOISE

- A. Provide integral horsepower motors with overall sound power levels meeting the requirements of MG 1-12.49.

2.14 STARTERS

- A. Provide starters for any motor not equipped with VFD.

2.15 MOTOR HEATERS

- A. Provide motor heaters on all motors larger than 5 HP that are located in exterior, unconditioned, or semi conditioned spaces. Heaters shall be controlled off a normally closed contact from the motor starter.
 1. Type. Electric resistance, silicon rubber clad or equivalent non-oxidizing exterior, with maximum surface temperature of 130°C(266°F). Alternatively, provide two stainless steel sheathed conventional space heaters, each with the rated watts at the specified voltage equal to twice the required value, and connected in series.
 2. Wattage. As required to avoid condensation during shutdown, but not less than twice the value given in the Appendix of IEEE Standard 43, paragraph A 1.3 (twice the length in feet multiplied by the diameter in feet divided by 35).
 3. Voltage. 230 volts, single phase, 60 hz but operated at 120V

2.16 SEVERE DUTY MOTORS

- A. Motors that are specified in their respective section to be severe duty motors shall be in accordance with IEEE 841 Severe Duty Motors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Properly install and align motors in the locations as shown on Drawings. Use crimp-on, solderless copper terminals on the branch circuit conductors. For motors 20 horsepower and larger, use 5300 Series 3M motor lead splicing kit or approved equivalent.

- B. Nameplate must be in full view when motor and equipment are installed.
- C. If a motor horsepower rating larger than indicated is offered as a substitute and is accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches, and other related items at no change in contract price.

3.02 FIELD TESTING

- A. Provide instruments, labor and personnel required to perform motor inspection and testing.
- B. Inspect all motors for damage, moisture absorption, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification, and cleanliness. Report abnormalities to Owner's Representative before energizing.
- C. Megger test all motors 20 horsepower and larger in accordance with IEEE Report No. 43, "Recommended Practices for testing Insulation Resistance of Rotating Machinery" to determine insulation resistance.
- D. Measure full load current and full load voltage.
- E. Complete and submit Motor Test Report forms to Owner's Representative.
- F. After installation has been thoroughly checked and found to be in proper condition with thermal overloads in motor controllers properly sized and all controls in place, energize the equipment at system voltage for operational testing.

END OF SECTION

SECTION 23 0515
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish complete the variable frequency drive (VFD) units as specified herein. All features described shall be included within the VFD enclosure.
- B. This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with both asynchronous and permanent magnet motors.
- C. The drive manufacturer shall supply the drive and all necessary options as specified. All drives installed on this project shall be from the same manufacturer and have a common user interface (control panel). The manufacturer shall have been engaged in the production of this type of equipment for a minimum of 30 years. Drives that are manufactured by a third party and "brand labeled" shall not be acceptable. Drive manufacturers who do not build their own power boards and assemblies, or do not have full control of the power board manufacturing and quality control, shall be considered as a "brand labeled" drive.

1.02 RELATED WORK

- A. Section 23 00 10, Mechanical General Provisions.
- B. Section 23 05 13, Common Motor Requirements for HVAC Equipment.
- C. Section 23 34 13, Fans.
- D. Section 23 73 13, Air Handling Units.
- E. Section 26 00 00, Electrical General Provisions.
- F. Section 28 31 00, Fire Alarm System.

1.03 SUBMITTALS

- A. Submit complete product data, shop drawings, and wiring diagrams, including the rated input current of the VFD. Data shall clearly indicate the current distortion produced by the VFD. See Part 2 of this specification for requirements. Make submittals under the provisions of Section 23 00 10 and Division 01.
- B. Product Data:
 - 1. Provide literature that indicates dimensions, weights, capacities, performance, gages and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring. Coordinate submittal with Direct Digital Controls supplier for interface with building control system.
 - 3. Ratings, including voltage and continuous current or horsepower.
- C. Shop Drawings:
 - 1. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
 - 2. Dimensioned drawings. Outline dimensional drawings of each size and type of variable frequency drive (VFD) proposed for use on this project. Include top and bottom views showing conduit entry and exit space, front and side elevations showing arrangement of devices, ventilation and cooling provisions, required clearances, and connection details. Include weight of each size and type of VFD proposed for use on this project, and mounting provisions.
- D. Prior to Installation, Startup, and Testing:
 - 1. Submit manufacturer's written installation instructions.

2. Submit written procedures for field testing to be performed under Part 3 of this Section. Procedures shall include prerequisite and initial conditions, a list of required test instruments, and forms for documentation of test results. Testing forms shall include the range of acceptance values for each recorded parameter.
3. Operation and Maintenance Manuals. Submit O&M manuals in accordance with the requirements of Section 23 00 10 and Division 01. Include instructions for routine service, spare parts lists, and wiring diagrams.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit O&M manuals in accordance with the requirements of Section 23 00 10 and Division 01. Include instructions for routine service, spare parts lists, and wiring diagrams.
- B. Include copy of approved submittals (with all comments corrected) and final as-built drawings/information.
- C. Manufacturer's Field Start-up Report and Certification, as specified in Part 3, this Specification.

1.05 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. UL Compliance:
 1. Comply with UL 508A, UL 508C, or UL 61800-5-1
 2. Comply with UL 60947-4-1A for Motor Starters and Contactors.
- C. IEEE Compliance:
 1. Comply with IEEE 112-B, Test Procedure for Polyphase Induction Motors and Generators.
 2. Comply with IEEE 519, Harmonic Control in Electrical Power Systems.
 3. Comply with ANSI/IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.
- D. NEMA Compliance:
 1. Comply with NEMA ICS 7, AC Adjustable Speed Drives.
 2. Comply with NEMA MG-1 for Motors.
- E. Qualifications:
 1. Drives shall be UL labeled as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR when installed in accordance with the manufacturer's guidelines.

1.06 WARRANTY

- A. The warranty shall be 30 months from the date of shipment from the factory to jobsite. The warranty shall include parts, on-site labor, and travel time and travel costs, or replacement of the complete drive as determined by the drive manufacturer's technical support.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. ABB.
- B. Square D.
- C. Approved equal. Refer to Section 23 00 10 for substitutions.

2.02 VFD UNIT

- A. The variable frequency drive (VFD) motor controller shall convert 480 Volt, three-phase, 60 Hertz power to adjustable voltage (0 - 480V) and frequency (0 - 60 Hz.) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed range.
- B. The VFD shall be designed and constructed to operate within the following conditions:
 1. The drive shall provide full rated output from a line of +10% to -15% of nominal voltage.
 2. The drive shall continue to operate without faulting from a line of +25% to -35% of nominal voltage.

3. Drives shall be capable of continuous full load operation under the following environmental operating conditions:
 - a. Ambient temperature 14 to 104° F.
 - b. Altitude 0 to 3,300 ft above sea level.
 - c. Humidity 5 to 95%, non-condensing.
 4. AC Line Voltage Variation. -30 percent to +10 percent
 5. AC Line Frequency Variation. 3 Hertz.
 6. Output Frequency. Shall be able to operate at the rated motor horsepower up to 90 hertz without damage to the VFD.
- C. The adjustable frequency controller shall be a space vector sine-coded Pulse-Width Modulated (PWM) or IGBT design. Modulation methods which incorporate "gear-changing" techniques are not acceptable.
- D. The controller shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.
- E. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFD's are operated from the same bus.
- F. Individual or simultaneous operation of VFD's shall not add more than the total harmonic voltage distortion and no more than the total harmonic current distortion allowed by the latest edition of IEEE 519 to the normal bus.
1. The VFD manufacturer shall provide calculations specific to this installation, showing total harmonic voltage distortion is less than the maximum allowed by the latest version of IEEE 519.
 2. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE Standard 519. The resultant power factor with the addition of the filter shall be a minimum of 97%. All 6-pulse VFD's shall include a minimum of 5 percent impedance reactors, no exceptions.
 3. VFD's supplied shall be a combination of 6-pulse and/or low harmonic VFDs required to comply with IEEE-519 noted above.
- G. The VFD shall be provided with a harmonic filter that limits the current distortion to 5% or less. The resultant power factor with the addition of the filter shall be a minimum of 97%.
1. Assume the following input power conditions:
 - a. 98% power factor.
 - b. Nominal voltage and frequency.
- H. Any inverter that generates sufficient electrical line noise to interfere with operation of sensitive building equipment (including computers) shall be field modified or replaced by the inverter supplier at no additional cost to the Owner.
- I. The VFD shall be provided with an RS-485 port with removable terminal blocks. The onboard protocols shall be LonWorks. The use of third-party gateways is not acceptable.
- J. The VFD shall include RFI/EMI filters to prevent high frequency noise interference from migrating back onto the power system and RFI interference with other equipment.

2.03 SCHEDULE

- A. In general, capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. One controller shall control the speed of one motor only unless indicated otherwise on the drawings. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the Owner.

- B. Where rating of driven equipment furnished for this project is larger than scheduled or indicated on Drawings, provide variable speed drive suitable for driven equipment. Coordinate submittal data and unit selections with submittal data for driven equipment.
- C. Provide VFDs as follows unless otherwise specified on the equipment schedule:
 - 1. For equipment that is redundant, provide VFD without a constant speed bypass.
 - 2. For equipment that is not redundant, provide VFD with a constant speed bypass.
- D. Refer to the Drawing Schedules for sizes and ratings of the motors. Refer to other Sections for description of motors and their use.

2.04 BASIC DESCRIPTION

- A. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.
- B. The controller shall have a continuous output current rating of 100 percent of motor nameplate current.
- C. The VFD shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage.
- D. The inverter output shall be generated by Darlington IGBT power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load.

2.05 FEATURES

- A. The door of each power unit shall include a control panel (keypad) user interface.
 - 1. Text
 - a. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable).
 - b. Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.
 - c. Safety interlock, run permissive, and external fault status shall have the option of additional customized project specific terms, such as: AHU-1 End Switch, Office Smoke Alarm, CT-2 Vibration.
 - 2. The control panel shall include at minimum the followings controls:
 - a. Four navigation keys (Up, Down, Left, Right) and two soft keys to simplify operation and programming.
 - b. Hand-Off-Auto selections and manual speed control without having to navigate to a parameter.
 - c. Fault Reset and Help keys. The Help key shall include assistance for programming and troubleshooting.
 - 3. Multiple Home View screens shall be capable of displaying up to 21 points of information. Customizable modules shall include bar charts, graphs, meters, and data lists. Displays shall provide real time graphical trending of output power, frequency, and current within selectable intervals of 15/30/60 minutes and 24 hours.
 - 4. The control panel shall display the following items on a single screen; output frequency, output current, reference signal, drive name, time, and operating mode (Hand vs Auto, Run vs Stop). Bi-color (red/green) status LED shall be included. Drive (equipment) name shall be customizable.
 - 5. There shall be a built-in time clock in the control panel. The clock shall have a battery backup with 10 years minimum life span. Daylight savings time shall be selectable.

6. I/O Summary display with a single screen shall indicate and provide:
 - a. The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs. Drives that require access to internal or live components to measure these values, are not acceptable.
 - b. The programmed function of all analog inputs, analog outputs, digital inputs, and relay outputs.
 - c. The ability to force individual digital I/O high or low and individual analog I/O to desired value, for increased personal protection during drive commissioning and troubleshooting. Drives that require access to internal or live components to perform these functions, are not acceptable.
7. The drive shall automatically backup parameters to the control panel. In addition to the automatic backup, the drive shall allow two additional unique backup parameter sets to be stored. Backup files shall include a time and date stamp. In the event of a drive failure, the control panel of the original drive can be installed on the replacement drive, and parameters from that control panel can be downloaded into the replacement drive.
8. The control panel shall display local technical support contact information as part of drive fault status.
9. The control panel shall be removable, capable of remote mounting.
10. The control panel shall have the ability to store screen shots, which are downloadable via USB.
11. The control panel shall have the ability to display a QR code for quick access to drive information.
12. The LCD screen shall be backlit with the ability to adjust the screen brightness and contrast, with inverted contrast mode. A user-selectable timer shall dim the display and save power when not in use.
13. The control panel shall include assistants specifically designed to facilitate start-up. Assistants shall include: First Start Assistant, Basic Operation, Basic Control, and PID Assistant.
14. Primary settings for HVAC shall provide quick set-up of all parameters and customer interfaces to reduce programming time.
15. The drive shall be able to operate with the control panel removed.
- B. The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from overcurrent, overvoltage, undervoltage, or overtemperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.
- C. A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.
- D. Automatic restart after drive trip or utility failure. Software selectable if not desired.
- E. Speed profile. Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points.
- F. Process signal inverter. Software selectable to allow speed of drive to vary inversely with input signal.
- G. A critical speed avoidance circuit will be included for selection of a minimum of two critical speeds ranges with a rejection band centered on that speed. The drive will ignore any speed signals requiring drive operation within the rejection band.
- H. Proportional and integral setpoint process controller with menu driven selection and programming via door-mounted keypad.
- I. Pick up a spinning load. The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping.

- J. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power with a minimum 100 kAIC rating.
- K. Bypass (where required)
 - 1. The constant speed bypass shall be provided to allow the motor to run across the line in the event of VFD shutdown. The transfer from the VFD to the line shall be accomplished manually by means of a selector switch. The bypass circuitry shall be enclosed separate from the VFD in a NEMA-1 or UL Type 1 cabinet.
 - 2. The bypass cabinet shall include a door-interlocked input circuit breaker, a VFD output contactor, a full-voltage starting contactor (both contactors electrically interlocked), a thermal overload relay to provide motor protection, a phase loss/undervoltage relay and a control power transformer. Mounted on the cabinet door shall be a two line LCD display to indicate status of the bypass operation (i.e. VFD output contactor failure or bypass contactor failure, etc.), VFD bypass selector switch, motor fault light, power "ON" light, motor "ON" VFD light, and motor "ON LINE" light. The bypass shall have four digital inputs for individual safety interlocks, damper end switch interface and provide voltage and current reading on all 3 phases as well as KW.
- L. Three programmable multi-function output relays (Form A rated 2 A @ 250 VAC & 30 VDC), providing 50+ functions, including: damper control, hand/auto status, contactor control for external bypass, over torque/under torque detection, serial communication status and no load detection (broken belt alert).
- M. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
- N. The drive shall have cooling fans that are designed for field replacement. The primary cooling fan shall operate only when required and be constant or variable speed
- O. Drives serving fans (cooling towers, air handling units, exhaust fans) shall have the ability to provide a blade breaking load to prevent the cooling tower fan from spinning backwards.
- P. Normally the digital display shall simultaneously display:
 - 1. Speed demand in percent.
 - 2. Output current in amperes.
 - 3. Frequency in Hertz or RPM.
 - 4. Control Mode: Manual/Automatic.
 - 5. Total three-phase KW or output volts.
- Q. The VFD shall include a motor preheat function to prevent motor condensation build up during shut down periods.

2.06 ENCLOSURE

- A. VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-1 or UL Type 1 enclosure. NEMA or UL Type 12 enclosure is acceptable in lieu of NEMA UL Type 1 enclosure. Enclosure shall be UL listed as a plenum rated VFD.
- B. Finish. Apply a finish to enclosure cabinet, trim, and doors. Exterior and interior metal surfaces shall be cleaned and finished with electrostatically applied "powder coat" thermoset enamel baked over a rust-inhibiting phosphatized coating.

2.07 PROTECTIVE FEATURES AND CIRCUITS

- A. The controller shall include the following protective features:
 - 1. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.
 - 2. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.
 - 3. Static overspeed (overfrequency) protection.
 - 4. Line loss and undervoltage protection.
 - 5. Power unit overtemperature protection.
 - 6. Electronic motor overload protection.

7. Responsive action to motor winding temperature detectors or thermostatic switches.
8. Isolated operator controls.
9. Input line circuit breakers.
10. Be insensitive to incoming power phase sequence.
11. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.
12. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.
13. Individual transistor overcurrent protection.

2.08 PARAMETER SETTINGS

- A. The following system configuring settings shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.
- B. Motor Nameplate Data:
 1. Motor frequency.
 2. Number of poles.
 3. Full load speed.
 4. Motor volts.
 5. Motor full load amps.
 6. Motor KW.
 7. Current minimum.
 8. Current maximum.
- C. VFD Limits:
 1. Independent accel/decel rates.
 2. No load boost.
 3. Vmin, Vmax, V/Hz.
 4. Full load boost.
 5. Overload trip curve select (Inverse or Constant).
 6. Min/Max speed (frequency).
 7. Auto reset for load or voltage trip select.
 8. Slip compensation.
 9. Catch-A Spinning-Load select.
 10. Overload trip time set.
- D. VFD Parameters:
 1. Voltage loop gain.
 2. Voltage loop stability.
 3. Current loop stability.
- E. Controller Adjustments:
 1. PID control enable/disable.
 2. Setpoint select.
 3. Proportional band select.
 4. Reset time select.
 5. Rate time select.
 6. Input signal scaling.
 7. Input signal select (4-20mA/0-5 Volts).
 8. Auto start functions: On/Off, Delay On/Off, Level Select On/Off.
 9. Speed Profile: Entry, Exit, Point Select.
 10. Min, Max Speed Select.
 11. Inverse profile select (allows VFD speed to vary directly or inversely with input signal.)

2.09 DIAGNOSTIC FEATURES AND FAULT HANDLING

- A. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source responsibility, availability of service and access to spare parts).
- B. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 3 most recent events:
 - 1. VFD mode (Auto/Manual).
 - 2. Date and Time stamped for each fault
 - 3. Elapsed time (since previous fault).
 - 4. Type of fault.
 - 5. Reset mode (Auto/Manual).
- C. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 M/Sec. intervals for the 10 intervals immediately preceding a fault trip:
 - 1. VFD mode (manual/auto/inhibited/tripped/etc.).
 - 2. Speed demand.
 - 3. VFD output frequency.
 - 4. Drive inhibit (On/Off).
 - 5. Feedback (motor) Amps.
 - 6. VFD output volts.
 - 7. Type of fault:
 - a. Inverter O/Temp.
 - b. Over Voltage.
 - c. Detection Error.
 - d. Earth Leakage.
 - e. Watchdog.
 - f. PSU Power Fail.
 - g. Manual Test.
 - h. Out of Sat 1-6.
 - i. Software Fault.
 - j. Waveform Gen.
 - k. Remote Watchdog.
 - l. Thermistor.
 - m. Sustained O/L.
 - n. Bypass SCR Trip.
- D. The fault log record shall be accessible via a RS485 serial link as well as line by line on the keypad display.

2.10 QUALITY ASSURANCE AND FACTORY TESTS

- A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
 - 1. Power transistors, SCR's and diodes shall be tested to ensure correct function and highest reliability.
 - 2. Controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.
- B. Manufacture of VFD shall certify in shop drawings that VFD and equipment motors are compatible. Contractor shall provide VFD manufacturer complete motor data prior to submittal of shop drawings.
- C. Manufacturer shall provide a 3 year warranty on parts and labor to owner for each VFD from date of acceptance by Owner.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under the provisions of Section 23 00 10.
- B. Deliver products on site in factory fabricated protective containers, with factory installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place, elevated above grade, and protected from weather, sunlight, dirt, moisture, corrosion, and construction traffic.
- D. Handle carefully to avoid damage to components, enclosures, and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and shall not be installed on the project.

3.02 PREPARATION

- A. Verify that surfaces are ready to receive Work.
- B. Verify that field measurements are as shown on Shop Drawings and as instructed by manufacturer.
- C. Verify that required utilities are available, in the proper location, and ready for use.

3.03 INSTALLATION

- A. Install VFD in accordance with manufacturer's published, printed instructions.
- B. Mounting.
 - 1. Mount VFD on Unistrut mounted to wall or on Unistrut frame as indicated on detail.
 - 2. Height. In general, mount units so that operating handle is approximately 60 inches above finished floor. Where grouped, align tops of units.
 - 3. Ensure that proper clearance is provided for enclosure as required per NEC Table 110.26(A)(1) for working clearance and dedicated equipment space. Ensure that proper clearance is provided for enclosure as required by manufacturer for proper cooling of VFD.
- C. Coordinate with Division 26 to complete raceway, power wiring, and grounding in accordance with the requirements of the NEC and the recommendations of the VFD manufacturer as outlined in the installation manual.
- D. Contractor shall verify the existence and proper installation and operation of auxiliary contact on all disconnects located between the load and the drive. Auxiliary contact shall command the VFD to shut down as required to protect the VFD from damage. Any disconnects found lacking this function shall be corrected prior to the startup of the equipment.
- E. Interface:
 - 1. Controls. Coordinate with the controls supplier to accomplish proper interface with the building automation system (BAS) direct digital controls (DDC). Refer to Division 23 for Direct Digital Controls.
 - 2. Fire Alarm. Coordinate with Division 28 and the fire alarm supplier to accomplish proper interface with the fire alarm system, as indicated on the Drawings. Refer to Division 28, Fire Alarm System.
 - 3. Shutdown. Coordinate with other divisions to accomplish proper interface for shutdown of VFD, as indicated on the Drawings and as specified in the construction documents.
- F. Immediately prior to final acceptance, replace all air filters in VFD and clean inside of drives.
- G. Manufacturer shall provide start-up services and training as follows:
 - 1. Start-up for Contractor to verify correct installation and proper operation, including power and controls wiring connections..
 - 2. Start-up for Controls Vendor to verify that VFD correctly responds to control command functions and provides alarm condition to control center.
 - 3. Provide a report for each VFD indicating start-up is complete and/or noting any deficiencies found with the installation. VFD report must be provided to engineer prior to substantial completion.

4. Provide training as indicated in Specification 23 00 10 and this paragraph. The training shall be classroom instruction complete with visual aids, documentation, circuit diagrams and hands-on training. This course shall not be construed as a sales meeting, but rather as a school to familiarize the Owner with the care, troubleshooting, and servicing of the VFD.

END OF SECTION

**SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes the following for hydronic piping:
 - 1. Thermometers.
 - 2. Gauges.
 - 3. Pressure and Temperature Taps.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, submit detailed shop drawings and manufacturer's data, including:
 - 1. Measurement tolerances.
 - 2. Range.
 - 3. Accuracy.
 - 4. Device dimensions and connection sizes (include schedule indicating stem length versus pipe diameter).
 - 5. Scales.
 - 6. Materials of construction.
 - 7. Valves that will be used for isolating gauges.
- B. Submit a schedule for each device to be installed, including:
 - 1. Location.
 - 2. Pressure or temperature range of device and fluid measured.
 - 3. Temperature or pressure of fluid.
 - 4. Pipe size and bulb length of thermometers.
 - 5. Type of valve used with the Pressure Gauge.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Thermometers: Calibrate against standards traceable to the NIST and guaranteed accurate to plus or minus one scale division.
- B. Pressure Gauges: ASME B40.1 Grade 2A accuracy 0.5 percent of scale range.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
 - 1. Thermometers: Ashcroft, Dwyer, Marsh Instrument, Trerice, Weiss, Weksler
 - 2. Pressure Gauges: Ashcroft, Dwyer, Trerice, Weiss, Weksler
 - 3. Pressure/Temperature Taps: Peterson Engineering Company, Sisco or Trerice

2.02 GLASS THERMOMETERS

- A. Construction: Provide mercury free liquid in glass thermometer with a molded Valox polyester or cast aluminum case.
- B. Window: Plastic or Glass.
- C. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- D. Scale: 9-inches long, white scale with black graduations and figures.
- E. Stem: Aluminum or Stainless steel, thermowell installation, 1/4-inch diameter, minimum 3-1/2 inch straight or angle form of length to suit installation.

- F. Accuracy: Plus or minus 1 percent of full scale.
- G. Furnish thermometers for services in the following ranges and divisions:
 - 1. Chilled Water: 0 to 100 degrees F, 1 degree divisions
 - 2. Heating Hot Water: 30 to 240 degrees F, 2 degree divisions
 - 3. Condenser Water: 30 to 130 degrees F, 1 degree divisions
 - 4. Process Chilled Water: 0 to 100 degrees F, 1 degree divisions

2.03 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Brass or stainless steel with pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2 inch lagging protrusion. Locate thermometer wells so the sensing bulb will give a true and correct reading. Install thermometer so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2 inch and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well.

2.04 PRESSURE GAUGES

- A. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Liquid-filled type, polypropylene case, 4-1/2 inch diameter, solid front with blow-out back.
 - 2. Bourdon Tube: Bronze or 316 stainless steel with brass or stainless steel socket.
 - 3. Movement: 300 series stainless steel rotary type with stainless steel bushings
 - 4. Dial: White face with black figure.
 - 5. Pointer: Red or black, micro adjustable.
 - 6. Window: Molded Acrylic.
 - 7. Ring: Fiberglass polypropylene.
 - 8. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 - 9. Gauge Ranges
 - a. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.
- B. Pressure-Gauge Fittings:
 - 1. Valves: NPS 1/4 brass or stainless-steel needle type.
 - 2. Siphons: NPS 1/4 coil of brass or stainless steel tubing with threaded ends.
 - 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.05 PRESSURE AND TEMPERATURE TAPS:

- A. Taps. Provide 1/2" solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel and fitted with a color-coded cap and gasket. P/T Taps shall be rated for 275 degrees F. and 1000 psig. Provide long stem type for insulated pipe.
- B. Instruments. Provide two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two each, thermometers for chilled water, heating and domestic hot water systems, when applicable. Applicable meaning the system is being installed as part of the project. "Pete's Plugs" to match insulation thickness.

PART 3 EXECUTION

3.01 THERMOMETER INSTALLATIONS

- A. Provide thermometers and thermometer wells in the following locations:
 - 1. Inlet and outlet of each air handling unit coil connection.
 - 2. Inlet and outlet of for supply and return connections of each heat exchanger.
 - 3. As shown on Drawings and control schematics.
- B. Install direct-mounting thermometers and adjust vertical and tilted positions.

- C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

3.02 GAUGE INSTALLATIONS

- A. Provide pressure gauges in the following locations:
 - 1. Suction and discharge side of each pump.
 - 2. Each hydropneumatic tank.
 - 3. Inlet and outlet of each air handling unit coil.
 - 4. Supply and return piping connections of coils (where shown on details).
 - 5. Inlet and outlet of each heat exchanger vessel.
 - 6. As shown on Drawings and control schematics.
- B. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
- C. Install needle-valve in piping for each pressure gauge for fluids.
- D. Install snubber for gauges associated with pumps.
- E. Provide fittings as necessary to install pressure gauge in the vertical position.
- F. Provide liquid filled gauges upstream and downstream of all pumps.

3.03 PRESSURE AND TEMPERATURE TAP INSTALLATIONS

- A. Provide pressure and temperature taps at the following locations:
 - 1. Inlet and outlet of each coil connection.
 - 2. Inlet and outlet of each hydronic control valve
 - 3. Inlet and outlet of for supply and return connections of each heat exchanger.
 - 4. Where shown in details on mechanical drawings.

3.04 CONNECTIONS

- A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance for thermometers, gauges, machines, and equipment. Thermometer

3.05 ADJUSTING

- A. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION

**SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installing heating water, chilled water piping, condensate piping valves, and appurtenances, including fittings and strainers.
- B. Related Sections:
 - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
 - 2. Section 23 05 53, Identification for HVAC Piping and Equipment, for valve tags and schedules.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data showing compliance with requirements of Part 2. Clearly indicate piping, equipment, materials of construction, pressure rating and which options are to be provided.
- B. Victaulic products shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions.
- B. Piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

1.04 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.
- C. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: Provide an insulated stem extension.
 - 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.

2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Check Valves: Apco, Crane, Keckley, Kitz, Mission, Milwaukee, Mueller, Nibco, Powell, Southern California Valve, Stockham, Titan and Weco.
 2. Plug Valves: DeZurik, Keystone, Mueller, or Stockham.
 3. Globe Valves: Crane, Kitz, Milwaukee, Nibco, Powell, or Stockham.
 4. Butterfly Valves: Apollo, Bray, Clow, Demco, DeZurik, Crane, Kitz, Milwaukee, Nibco, Pratt, or Stockham.
 5. Ball Valve: Apollo, Crane, DeZurik, Kitz, Milwaukee, Nibco, or Watts.
 6. Strainers: Apollo, Armstrong, Keckley, Mueller Spirax or Watts.
 7. Where grooved piping is allowed, check valves, butterfly valves, ball valves, and strainers as manufactured by Victaulic.
 8. Coil Packs: IMI Hydronic Engineering Inc., HCl, Nexus, Nibco, Pro Hydronic Specialties, Victaulic Koil-Kits.

2.03 CHECK VALVES

- A. For pipe 2 inches in diameter and smaller, furnish 150-pound (class 150) screwed, horizontal, swing check valve, all bronze construction, with screwed cap.
- B. For pipe 2-1/2 to 10 inches in diameter, provide 125-pound (class 125), lugged style, drill and tapped, or retainerless wafer lug style, double door valve, with cast iron or cast steel body and aluminum bronze doors, Buna-N seat, and Type 316 stainless steel spring. At Contractor's option, a tapped double flange valve may be provided.
- C. For pipe 10 inches in diameter and larger, provide 125-pound (class 125), raised-face, lugged style, drill and tapped, or retainerless wafer lug style, double door valve, with cast iron or cast steel body and aluminum bronze doors, Buna-N seat, and Type 316 stainless steel hinge pin, stop pin, thrust bearing and spring. At Contractor's option, a tapped double flange valve may be provided.

2.04 PLUG VALVES

- A. For pipe 2 inches in diameter and smaller, use 150-pound (class 150) screwed, eccentric plug valve with a bronze body, bolted bonnet, Fluorinated Hydrocarbon (Viton) Filled PTFE packing, Isobutene-Isoprene or Viton faced plug, stainless steel bearings, lever operated with adjustable memory stop, non-lubricated, short pattern plug valve.
- B. For pipe 2-1/2 inches in diameter or larger, furnish 150-pound (class 150) flanged eccentric plug valve, with cast iron steel, bolted bonnet, Buna (Vee) packing, Isobutene-Isoprene or Viton faced plug, stainless steel bearings, lever operated with memory stop through 8 inch size, and totally enclosed handwheel actuators above 8-inch size, non-lubricated, short pattern plug valve.

2.05 GLOBE VALVES

- A. For pipe 2 inches in diameter and smaller, provide 150-pound (class 150) screwed, rising stem, globe valve with bronze body, TFE disc, union bonnet.
- B. For pipe 2-1/2 through 10 inches in diameter, provide 125-pound (class 125) flanged, OS&Y globe valve, with cast iron body, renewable bronze trim.

2.06 BUTTERFLY VALVES

- A. For pipe 2-1/2 through 12 inches in diameter, furnish butterfly valve with ductile iron body and ANSI 150 pound tapped lug type, suitable for bi-directional differential pressure rating of 200-psi, stainless steel stem, bronze or stainless steel disc with EPDM liner. Furnish valves with totally enclosed worm gear operators. Use valves designed for drip-tight shutoff in dead end service against 200 psi.
- B. For 14 inch diameter pipe and larger, furnish butterfly valve with ductile iron body and ANSI 150 pound tapped lug type, suitable for bi-directional differential pressure rating of 200-psi, stainless steel stem, and bronze or stainless steel disc with EPDM liner. Provide totally enclosed worm gear operators for all valves. Provide valves designed for drip tight shutoff in dead end service against 150 psi.
- C. Where balancing valve is shown, provide butterfly valve with adjustable stops (memory stop) for valves with worm gear operators.

2.07 BALL VALVES

- A. For pipe 2 inches in diameter and smaller, provide 600 psi WOG screwed, two piece bronze or forged brass body, Teflon seat, full port, stainless steel stem and ball. Provide extension stem and insulated handle for valves installed in insulated piping. Where ball valves are used as balancing valves, provide valve with memory stop.

2.08 STRAINERS

- A. For pipe 2 inches in diameter and smaller, use 125-pound (class 125) cast bronze screwed Y-type strainer with 12-mesh stainless steel screen. Provide full size blowoff ball valve where shown on drawings.
- B. For pipe 2-1/2 inches and larger, provide 150-pound (class 150) cast steel or iron flanged Y-type strainer with 0.045 inch stainless steel screen through 4, and 1/8 inch stainless steel screen for 6 inches and larger. Provide full size blowoff ball valve where shown on drawings.

2.09 VALVES FOR GROOVED PIPING SYSTEMS

- A. Check Valves
 - 1. For grooved piping systems, 2" through 12" Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc or elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi. Victaulic Series 716 or 779 (with venturi).
 - 2. For grooved piping systems 14" to 24" 230 psi, AGS grooved ends, spring-assisted dual disc check valve. ASTM A-536, Grade 65-45-12 coated ductile iron body, EPDM seat bonded to the valve body, 304 stainless steel disc, and 300 series stainless steel spring and shaft. Victaulic Series W715.
- B. Butterfly Valves
 - 1. For grooved piping systems, 2" through 12" Sizes: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be aluminum bronze or stainless steel with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. (Valve with EPDM seat is UL classified in accordance with ANSI/NSF-61.) Victaulic Vic®-300 MasterSeal™.

2. For grooved piping systems, 14" through 24" Sizes: 300 psi, AGS grooved ends, polyphenylene sulfide (PPS) coated ductile iron body (ASTM A-536, Grade 65-45-12), PPS coated ductile iron disc (ASTM A-536), and two-piece 17-4 PH S/S stem design. Seat and seal material to suit intended service. Reinforced PTFE bearings and gear operator. Bubble tight, dead-end, or bi-directional service. With memory stop for throttling, metering or balancing service. Victaulic Vic®-300 AGS.
- C. Ball Valves
 1. For Vic-Press Sch. 10S 2 inches and smaller, CF8M stainless steel body, ball, and stem, PTFE seats, 304 stainless steel handle, nut, and stem washer, with Schedule 10S stainless steel type 316 Vic-Press™ and/or grooved ends. Rated for services to 400 psi. Victaulic Series P569. The valves shall have a blow-out proof stem and self-adjusting floating ball which provides uniform sealing. The full port design minimizes pressure drop for maximum flow efficiency. Valves shall be three-piece swing-out design to permit easy in-line maintenance.
- D. Strainers
 1. For grooved piping systems 2" through 18" sizes, 300 PSI Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" diameter perforations 2"-3" strainer sizes, 1/8" diameter perforations 4"-12" strainer sizes, and 0.156" diameter perforations 14" -18" strainer sizes. Victaulic Style 732 and W732.

2.10 VALVES FOR FAN COIL UNITS (COIL PACK)

- A. General. The following products are for terminal boxes and fan coil units with pipe sizes 2-inches and less.
- B. Combination Ball Valve w/PT Test Port and Strainer w/blowdown valve. Provide dezincification resistant or forged brass construction, 600-pound, 230F construction with multiple 1/4" tapped ports for test plugs or other accessories and union end. Valve shall have blowout proof stem with stainless steel ball. Strainer shall have 20 mesh Type 304 stainless steel screen and 3/4" hose bib & cap.
- C. Combination Ball Valve w/Memory Stop and PT Test Port. Provide dezincification resistant or forged brass construction, 600-pound, 230F construction with multiple 1/4" tapped ports for test plugs or other accessories and union end. Valve shall have blowout proof stem with stainless steel ball.
- D. Combination PT Test Port w/Manual Air Vent. Provide dezincification resistant or forged brass construction, 600-pound, 230F construction with multiple 1/4" tapped ports for test plugs or other accessories and union end.
- E. PT Test Ports. Shall be rated for 1000 psi, 325F with brass body, Nordel check plugs and sealed cap.
- F. Stainless Steel Flex Hoses.
 1. Shall be designed for water and conform to ASTM codes E84, with stainless steel outer braid. Hoses 1/2-inch through 1-inch shall have a Kevlar reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 400 psi, 230F. Hoses 1 1/4-inches thru 2-inches shall have Rayon reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 300 psi, 230F. All hoses shall have at least one union or swivel end fitting and be maximum 18-inches in length.
 2. Stainless steel flex hoses are not allowed.
- G. Manual Air Vents. Shall be of brass construction and rated at 400 psi, 230F.
- H. Shaft extensions (2" and smaller). For insulated pipe shall be at least 2 1/4" tall and constructed of brass with a stationary external shaft housing to ensure vapor barrier seal.

PART 3 EXECUTION

3.01 STORAGE

- A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions. All piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

3.02 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.

3.03 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. Provide clearance for access to valves, fittings and equipment for operation and maintenance.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement and with operators and stems upright or horizontal.
- F. Install chainwheels on operators for butterfly, gate, and globe valves 2-1/2 inches and larger and more than 120 inches above floor in all mechanical rooms and other MEP spaces. Extend chains to 60 inches above finished floor.
- G. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.
- H. All piping shall be clean when it is installed.
- I. Check Valves. Install lugged check valves between flat flange and full-face gasket. Install check valves a minimum three to four pipe diameters downstream of pump discharge or elbows to avoid flow turbulence.

3.04 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor, at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.
- B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well, a balancing valve (with memory stop) for balancing, and valves for isolation of each coil.

3.05 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.
- B. Install 2-inch drain for 2-inch pipes and larger.
- C. Install a line size drain valve for pipes smaller than 2 inches.

- D. Provide hose adapter and cap on all drain lines.
- E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.06 TESTING

- A. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150-psig minimum, and carefully check for leaks.
- B. Remove or isolate valves, expansion joints, strainers and equipment that are rated at pressures less than test pressure.
- C. Repair all leaks and retest the system until proven leak tight.

3.07 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.

3.08 TRAINING

- A. A Victaulic factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. A Victaulic representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products. Refer to 23 21 13 Hydronic Piping and Fittings for Warranty requirements.

END OF SECTION

**SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installing supports, anchors, hangers, sleeves, and concrete equipment pads for all direct and isolated suspended and floor mounted HVAC equipment.
- B. See Division 05 Section, Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- C. See Section 23 0548, Vibration Isolation for HVAC Piping and Equipment, for vibration isolation devices.
- D. See Section 23 3113, Ductwork, for duct hangers and supports.

1.02 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.03 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.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog data, dimensional drawings and construction materials for the following:
 - 1. Steel pipe hangers and supports
 - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers as applicable:
 - 1. Anvil Intl., Inc.
 - 2. Superstrut, Mult-A-Frame, Unistrut and Power-Strut pipe support systems
 - 3. Specified Technologies, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Portable Pipe Hangers (PHP)

2.02 CONCRETE

- A. Provide minimum 3,000 psi concrete. Reinforce slab with minimum No. 4 rebar on 12-inch centers each way, centered in slab unless otherwise indicated on Drawings.

2.03 STRUCTURAL METAL

- A. Furnish structural metal as specified in Division 05 and as shown on Drawings.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers for insulated and non-insulated pipes, provide galvanized carbon steel adjustable clevis hangers. Anvil Fig. 260 or equal.
- B. Multiple Hot Pipes and insulated cold pipes supported by a trapeze hanger, provide cast iron roll with galvanized finish cast iron roll beneath each pipe.
- C. Multiple or Trapeze Hangers: Provide Galvanized steel channels with welded spaces and hanger rods; cast iron roll with galvanized finish and stand for sizes 4 inches and large for heating and chilled water piping.
- D. Wall supports: Provide galvanized welded steel brackets and galvanized wrought steel clamp, galvanized adjustable steel yoke and cast iron roll. Anvil Fig. 194, 195, 199 as required by pipe size and weight. Submit to structural engineer for approval detailing method of attachment to wall.
- E. Vertical Support: Provide galvanized riser clamp with field welded shear lugs. Anvil Fig 261 or Fig 40 as required by installation and loads to be supported. Refer to mechanical details for main riser supports.
- F. Floor supports for Pipe sizes to 4 inches and all cold pipe sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and steel support. Anvil Figures 264 or 265 as required.
- G. Floor supports for Hot pipe 6 inches and larger: Provide adjustable cast iron roll and stand, adjusting screws and steel support all galvanized. Anvil Fig. 274.
- H. Copper Piping Supports and Hangers: Provide copper plated carbon steel clevis hanger. Anvil Fig. Anvil CT-65.
- I. Provide galvanized hangers and supports for all piping and ductwork located in crawlspaces, pipe shafts and chases and above suspended ceiling spaces.
1. Provide hanger rods, bolts and nuts and all metal parts coated with same material as hangers.
 2. Prime coat and paint exposed steel hangers and supports.
- J. Provide pre-engineered pipe support system for rooftop ductwork and piping. System shall be hot dipped galvanized after fabrication. System shall be designed as to not damage the roof, and shall have a maximum load of 5 psi applied to the roof. Provide a rooftop walking pad under each support for the piping systems. Pipe supports shall be PHP Portable Pipe Hangers or equal.

2.05 PIPE SHIELDS

- A. Provide pipe shields for piping 2 inches and smaller fabricated of 20 gauge galvanized steel over insulation in 180 degree segments, minimum 12-inches long.
- B. Provide pipe shields for piping 2-1/2 inches and larger fabricated of galvanized steel over insulation in 180 degree segment as follows:

PIPE SIZE	METAL GAUGE	SHIELD LENGTH
2-1/2 to 6 inches	18	12 inches
8 to 16 inches	16	18 inches
18 inches and larger	12	24 inches

- C. Provide high density segment of insulation at shields at least two inches longer than shield. Foamglas blocks (HLB 1600) or factory made insulation shields as made by Pipe Shields, Inc. are acceptable. High density insulation segment shall be of sufficient compressive strength to prevent indentation of insulation jacket. Submit data indicating compressive strength of insulation segment. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

- D. Secure insulation shields to insulation jacket with adhesive as recommended by insulation manufacturer or 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals.

2.06 HANGER RODS

- A. Provide cadmium plated steel, threaded both ends continuous sized for supported load.

2.07 INSERTS

- A. Provide malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded rods. Submit data to structural engineer for approval. Anvil Fig. 282.

2.08 SLEEVES

- A. Fit with sleeves all pipes passing through gyp board, masonry and concrete construction. Provide sleeves in floors and walls of mechanical rooms, pump rooms, etc. constructed of schedule 40 steel with galvanized finish. Sleeves outside mechanical room type spaces shall be galvanized EMT conduit for 2 inch diameter sleeves. Sleeves outside mechanical room type spaces over 2 inch and thru walls shall be rolled 20 gauge galvanized steel with welded seam. All galvanizing shall be done after welding.
- B. Sleeves in floors shall be provided with a 1-1/2 inches wide center flange welded to sleeve and centered in slab. Refer to Drawings for additional requirements.
- C. Sleeves thru roofs: schedule 40 galvanized steel pipe.
- D. Caulk all sleeves water and airtight. Provide firestop compound at all penetrations of floor slabs and fire rated walls.
- E. Sleeves below grade in outside walls are detailed on drawings. Provide Link Seal casings at sleeves at all exterior walls above and below grade. Use stainless steel retainers, nuts and bolts in sleeves below grade. Size sleeves in accord with Link Seal recommendations.
- F. Size sleeves one pipe size larger than the pipe it serves including insulation thickness as appropriate.
- G. Extend each sleeve through the floor or wall. Cut the sleeve 1/2 inch beyond flush from each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.

2.09 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: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections for 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 copper hangers with copper pipe and nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing. As an alternate, tape copper pipe at all points contacting steel hangers, structural members or sleeves. Use a dual wrap of polyvinyl tape.
- E. Use padded hangers for piping that is subject to scratching.

3.02 PIPE HANGER AND SUPPORT INSTALLATION

- A. Support horizontal steel piping on center as follows:

PIPE SIZE	MAX HANGER SPACING
1/2 to 1-1/4 inches	6 feet
1-1/2 to 2 inches	10 feet
2-1/2 to 6 inches	10 feet
6 to 12 inches	10 feet
14 inches and larger	10 feet

- B. Place a hanger within 6 inches of each elbow
- C. Provide hangers with vertical adjustment of 1-1/2 inches minimum.
- D. For copper piping up to 1-inch place hangers not more than 5 feet apart, for 1-1/4 inch to 1-1/2 inch piping, place hangers not more than 7 feet – 0 inch apart and for 2-inch to 3-inch piping not more than 9 feet 0 inches apart.
- E. Larger Sizes: Support as recommended by manufacturer.
- F. Submit manufacturer's support and hanging recommendations.
- G. Support piping from structure independent from other piping installed above.
- H. Support risers as detailed on drawings at each floor and independently from connected horizontal pipe.
- I. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified above.
- J. Perforated bar hangers, straps, wires or chains are not permitted.
- K. Support piping from precast and pan joist structure as detailed on drawings.
- L. Powder actuated anchors are not permitted.
- M. Sleeves penetrating beams must be submitted for approval by Structural Engineer.

3.03 CONCRETE PADS

- A. Pour 6-inch pads on roughened floor slabs unless otherwise noted.
- B. Extend outer edges of pads minimum 2 inches beyond equipment.
- C. Chamfer edges of pads.
- D. Secure equipment with anchor bolts in accordance with equipment installation instructions.
- E. Air handling units shall be installed on concrete pads with adequately sized neoprene isolation pads at each air unit support point.
- F. Verify that housekeeping pads for air handling units are high enough to provide a condensate drain trap deep enough to override the air handler static pressure.
- G. Install pump inertia bases on 6 inch pads.
- H. Install expansion tanks on 6 inch pads.

3.04 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Bolt floor stands to 4 inch thick concrete pads or as shown on Drawings.
- C. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.
- E. Hot dip galvanize after fabrication.

3.05 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Hot dip galvanize after fabrication.
- D. Field Welding: Comply with AWS D1.1 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 contours of welded surfaces match adjacent contours.

3.06 ROOF CURBS

- A. Provide prefabricate curbs for roof mounted equipment.
- B. Furnish curbs suitable for slope of roof to ensure equipment is set level.

3.07 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.08 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.

END OF SECTION

SECTION 23 0548
VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes requirements for furnishing, installing, and adjusting vibration isolation, for mechanical equipment and piping, including bases of structural steel and concrete, with steel pouring forms and concrete reinforcing bars.
- B. Related Sections Include:
 - 1. Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
 - 2. Section 23 21 13, Hydronic Piping and Fittings.
 - 3. Section 23 34 13, Fans.

1.02 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 125 miles per hour or as determined by project's structural engineer, whichever is higher.
 - 2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.03 SUBMITTALS

- A. Product Data: Submit product data showing type, size, load, deflection, and other required information. Include clearly outlined procedures for installing and adjusting isolators. Submit Drawings for each item of equipment with complete isolation installation information.
- B. Submit detailing of inertia bases and locations of vibration, including weight of inertia base.

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Include copies of approved submittals and any submittal comments.
- C. Provide tab for each major type of equipment (fan coil units, pumps, piping, fans, etc.). Provide schedule of vibration isolator type with location and load on each. Include data on each isolator type that corresponds to:
 - 1. Spring diameter.
 - 2. Deflection.
 - 3. Compressed spring height.
 - 4. Point location of each isolator.
 - 5. Calculated load at each point.
 - 6. Field static deflection.
- D. Include copy of written certification from factory representative as required in Part 3 of this specification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control
 - 2. Mason Industries.

3. Metraflex
4. Vibration Eliminator Co., Inc.
5. Vibro-Acoustics
6. VMC (Amber/Booth, Korfund Dynamics)

2.02 ISOLATOR DESIGN

- A. Materials:
 1. Design and treat vibration isolators for resistance to corrosion.
 2. Steel components shall be PVC coated or phosphatized and painted with industrial-grade, corrosion-resistant enamel.
 3. Furnish zinc-electroplated or cadmium plated nuts, bolts and washers.
 4. All isolators exposed to the weather shall have the steel parts hot dip galvanized with a PVC coating or powder coated enamel.
 5. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.
- B. Design:
 1. Unless otherwise instructed, use spring-type vibration isolators for all equipment driven by motors of 3 horsepower and larger.
 2. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.
 3. Isolators must be sized for starting torque of equipment motors.
 4. Refer to Application Tables in Part 3 of this specification for minimum spring deflection.
 5. All spring isolators must be completely stable in operation and must be designed for not less than 30 percent reserve deflection beyond actual operation conditions.
 6. Height saving brackets used with isolators having 2-1/2-inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.03 ISOLATOR TYPES

- A. Design of isolator types listed is based on model numbers manufactured by Kinetics Noise Control, unless otherwise indicated. Subject to compliance with requirements provide named product.
- B. Type FDS: Adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. Bond neoprene pad or cup with a minimum thickness of 1/4 inch to the base plate or spring. Base isolator shall have provisions for bolting the isolator to the supporting structure. A minimum horizontal-to-vertical spring rate of 1.0 is required.
- C. Type FRS: Similar to Type FDS, but with addition of bottom load plate and restraint assembly for vertical restraint for wind loads or large torqueing forces.
- D. Type SH: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer, and steel washer.
- E. Type SRH: Combination spring and rubber hanger consisting of a rectangular steel box, coil spring, spring retainers, and an elastomeric mounting.
- F. Type SLP: Adjustable, open-spring isolator having one or more coil springs attached to a top compression plate and a base plate. Bond neoprene pad or cup with a minimum thickness of 1/4 inch to the base plate or spring. The spring assembly must fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolator includes restraining bolts for connecting the top plate and lower housing to prevent the isolated equipment from rising when drained of water.
- G. Type NGS: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16-gage galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.1 inch to 0.16 inch.

- H. Type NP: Waffle pad-type neoprene consisting of 2 inch by 2 inch square modules with 7/8 inch minimum thickness. Modules shall be capable of field cutting to match equipment support footing as required. Pads shall be sized for 30 psi load and a deflection of 0.18 inch.
- I. Type RD: Rubber-in-Shear neoprene isolators, with neoprene-coated metal surfaces, and top and bottom surfaces detailed to prevent slipping. Isolators shall have bolt holes in the base and thread hole at top surface for equipment attachment. Rated deflection shall be a minimum of 0.40 inches.
- J. Type RH: Elastomeric hanger consisting of a rectangular steel box and an elastomeric isolation element of neoprene. A high-quality synthetic rubber may be used if it contains anti-ozone and antioxidant additives. Design elements for approximately 1/2 inch deflection and load so that the deflection does not exceed 15 percent of the free height of the element.
- K. Type SS: Type 321 stainless steel hose and Type 304 stainless braid sheath, with carbon steel threaded fittings for pipe sizes 2 inches and less, and carbon steel flanges for pipe sizes 2-1/2 inches and greater. Hose shall have a maximum working pressure of 200 psi at 70°F through 4", 155 psi at 70°F through 12".
- L. Type REJ: Flexible pump connectors/expansion joints shall be of the molded twin spherical type. Provide neoprene with nylon construction, EPDM, or multi-layered (Kevlar) tire-cord fabric reinforcement with peroxide cured EPDM. Unit shall be rated at 225 PSI and maximum temperature of 225°F. Provide 150# flanges and galvanized aircraft cable or control rods.

2.04 ISOLATION BASES

- A. Type CIB-L: Mount equipment on concrete inertia blocks which weigh at least 1.5 times the weight of equipment supported. Obtain equipment assembly information from the equipment manufacturer and include with submittal, including dimensional data. Vibration isolation manufacturer shall furnish steel concrete pouring forms for floating concrete bases. Size each inertia base to extend a minimum of 4 inches outside the equipment base. In the case of belt-driven equipment, extend the base 4 inches beyond the end of the drive shaft. Provide T-shaped inertia bases where necessary to conserve space. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a minimum 1" clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Install vibration isolation, as specified, between inertia blocks and equipment (housekeeping) pads.
- B. Type SFB: A structural steel fan and motor base with NEMA standard motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive. Suspended equipment shall be designed to spread the base area of equipment for increased stability and to permit suspension with hanger rods.
- C. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer on indoor units, hot-dipped galvanized finish for steel bases located outdoors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.

- C. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Install motor driven equipment with vibration isolators as indicated in schedule below.
- F. Isolate pumped water-piping systems with spring-type vibration isolators as indicated in schedule.
- G. All open-type spring isolators shall be restrained as recommended by the manufacturer.
- H. Install full line size flexible connectors at the suction and discharge connection of each piece of equipment as indicated in schedule below. All connectors to be suitable for use at the pressure and temperature encountered at point of operation. Do not insulate Type REJ flex pump connectors installed in heating hot water systems.
- I. Isolation Bases
 - 1. The isolated equipment and its driving motor shall be mounted on a common inertia base and the base, in turn, shall be mounted on the scheduled vibration isolator type to prevent transmission of vibration and noise to the building structure.
 - 2. For floor mounted equipment, provide an equipment (housekeeping) pad under the isolation base.
 - 3. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.
 - 4. After piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. Isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length that will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load. All springs supporting piping that is connected to a piece of isolated equipment shall be sized for static deflection equal to that of the isolated equipment.

3.02 APPLICATION

- A. The following is a schedule of equipment and piping on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.
- B. Provide isolation for the following equipment:

Equipment	Isolator Type	Minimum Deflection (inches)
<u>Air Handling Units:</u> Roof Mounted – up to 15 HP Roof Mounted – 20 HP and over *Type FDS by AHU Manufacturer	FDS* FDS*	1 2
<u>Fan Coil Units:</u> Floor Mounted (slab on grade) Floor Mounted (non-slab on grade)	NGS RD	0.1 – 0.16 0.4 – 0.5

- C. Provide isolation for the following piping systems:

Piping Systems	Isolator Type	Minimum Deflection (inches)
Piping in Mechanical Rooms: Chilled Water Piping – All piping 1-1/2 inches and larger, except first two hangers adjacent to Equipment Heating Hot Water Piping – All piping 1-1/2 inches and larger, except first two hangers adjacent to Equipment.	SH SH	1 1
Equipment includes: Air Handling Units		
Air Handling Units: First two hangers adjacent to equipment	SH	1
Fan Coil Unit Piping: Suspended/Floor Mounted	SS	

3.03 STOCK REQUIREMENTS

- A. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made.

3.04 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.

3.05 FACTORY REPRESENTATION:

- A. After installation, furnish factory-trained representative of the isolation manufacturer to check various isolators and report measured versus anticipated deflection on all isolators. Have the representative submit written certification that the isolators have been installed in accordance with the specifications, manufacturer's recommendations and approved submittals.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.
 - 7. Duct labels.
 - 8. Access door labels.

1.02 SUBMITTAL

- 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.

1.03 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.

1.04 RELATED WORK

- A. Painting. Division 09.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Valve Tags
 - 1. Provide three-ring binder including valve tag information (8-1/2 x 11-inch paper).
 - 2. Each service shall be individually tabbed in the binder.
 - 3. For each valve tag, indicate service, function, valve position (NC or NO), floor, room location and nearest column numbers.
- C. Equipment Labels
 - 1. Provide three ring binder including equipment label information (8-1/2 x 11-inch paper).
 - 2. Each type of equipment (pumps, AHUs, etc.) shall be individually tabbed in the binder.
 - 3. For each item of equipment to be labeled, provide equipment identification number, floor, room location, and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.
 - 3. Seton Identification Products.

2.02 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 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 x 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. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: Background to contrast with letter color.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number.

2.03 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. Letter Color: Black. (Similar to Sherwin-Williams SW 4090)
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.
- F. 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 2/3 to 3/4 the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.04 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic.
 - 1. Labels shall be formed to cover full circumference of pipe and attach to pipe without fasteners or adhesive for pipe smaller than 6".
 - 2. Labels for pipe 6" and larger shall be attached to pipe with nylon cable ties.
- C. 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.

2.05 DUCT AND ACCESS DOOR LABELS

- A. Identify ductwork and access doors with stencil.
- B. Letter Color: Black. (Similar to Sherwin-Williams 4090)
- C. Lettering Size: At least 1-1/2 inches high.
- D. Paint: Shall meet VOC requirements per Division 09 painting specification.
- E. 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.
- F. Access Door Label Contents: Identify access doors with indicated equipment to be accessed.

2.06 VALVE TAGS

- A. Provide valves with 1 1/2 inch diameter stainless steel or brass valve tag with stamped and black-filled numbers. Service designations shall be 1/4 inch letters, and valve numbers shall be 1/2 inch letters. Service designations shall be approved by Architect/Engineer. Secure tags to valves by use of brass "S" hooks and brass chain. Secure chain to valve by use of copper or monel meter seals.

PART 3 EXECUTION

3.01 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.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment. Use fasteners for all equipment labels where possible. Where it is not possible to use fasteners, use adhesive.
- B. Locate equipment labels where accessible and visible.

3.03 VALVE TAG

- A. Install valve tags for all major valves. This shall include branch isolation and balancing valves, isolation valves for equipment such as air handling units, pumps, chillers, etc.
- B. Do not provide valve tags for isolation valves directly adjacent to fan coil units and terminal boxes.

3.04 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 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. Do not label drain piping where the floor drain is located adjacent to the equipment.
- B. Provide pipe labels for the following piping systems:
1. Chilled Water Systems
 2. Heating Hot Water Systems
 3. Drain lines

3.05 DUCT LABEL INSTALLATION

- A. Identify ductwork with stencil.
- B. Identify exhaust fan number, air handling unit number, service and area served.
- C. Locate identification at air handling unit or fan, at each side of penetration of structure or enclosure at each obstruction, every 20 feet on long horizontal runs. Provide identification for the following ductwork:
1. All exhaust (restroom, laboratory, kitchen, etc.) and relief ductwork.
 2. All supply air ductwork served by Air Handling Units
 3. All outside air ductwork, including pretreated outside air ducts.
 4. All return air ductwork, not including return air boots and transfer ducts.

3.06 ACCESS DOOR LABEL INSTALLATION

- A. Access Door Contents: Identify access doors with indicated equipment to be accessed., including, but not limited to the following:
1. Fire Dampers: FD
 2. Fire/Smoke Damper: FSD
 3. Smoke Damper: SD
 4. Airflow Measuring Station: AFMS
 5. Motorized Volume Damper: MVD
 6. Hot Water Coil: HWC

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REQUIREMENTS

- A. The Bidding and Contract Requirements and General Requirements apply to this work.
- B. All Division 21, 22, 23 Sections apply to this work.
- C. Section 01 91 13, Commissioning.

1.02 SCOPE OF WORK

- A. Testing, adjusting, and balancing (TAB) of the air conditioning systems, related ancillary equipment will be performed by an impartial technical TAB firm selected and employed by the Owner.
- B. As a part of this Contract, the Contractor and/or Mechanical Subcontractor shall make any changes in the sheaves, belts, dampers, valves, etc. required for correct balance as required by the TAB firm, at no additional cost to the Owner.
- C. The Contractor shall ship terminal boxes to the TAB firm for leak testing in his shop prior to installation. Refer to Section 23 3600, Air Terminal Units.
- D. The Mechanical Subcontractor shall provide and coordinate services of qualified, responsible subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.
- E. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Sections, the Contractor shall start-up and check-out all systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be acceptable to the Owner's Representative.
- F. Contract completion schedules shall provide sufficient time to permit the completion of TAB services prior to Owner occupancy.
- G. The Drawings and Specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Inspector shall be corrected by the Contractor immediately so the balancing work can proceed.
- H. The Contractor shall assist the TAB Firm with access, programming and operation of Building Controls (DDC) as required during balancing of the systems.
- I. Contractor must ensure that the necessary systems are scheduled to be in operation for TAB firm so that the access for balancing to diffusers, dampers etc., is not restricted. Contractor must schedule and coordinate activities so that TAB firm is not restricted from performing work, including access to damper operators and air devices.
- J. The Contractor shall correct deficiencies in a timely manner and produce a signed copy of the deficiency lists to the Owner. At that time, the TAB firm will return and verify that the deficiencies are corrected.

1.03 MATERIALS AND WORKMANSHIP

- A. The scope of the TAB work as defined herein is indicated in order that the Contractor and/or Mechanical Subcontractor will be apprised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB.

- B. The TAB firm will not have a contractual relationship with this Contractor but will be responsible to the Owner's Representative for the satisfactory execution of the TAB work. The Contractor shall allow sufficient funds in the project cost estimate and bid proposal to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.04 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor shall have the building and air conditioning systems in complete operational readiness and shall perform all other items as described hereinafter to assist the TAB Firm in performing the balancing, testing, and adjusting of the air and hydronic systems. He shall promptly correct deficiencies of material and workmanship identified as delaying completion of TAB work. The items shall include the following.
 - 1. Air Distribution Systems:
 - a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated.
 - b. All volume, splitter, extractor and fire dampers properly located and functional. Dampers shall provide tight closure and full opening, smooth and free operation.
 - c. All supply, return, exhaust, transfer grilles, registers, diffusers, and terminal units installed, leak tested and operational.
 - d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessively by-pass or leakage of air.
 - e. All fans (supply, return, relief and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; overload heater elements to be of proper size and rating; and clean filters installed.
 - 2. Water Circulating Systems:
 - a. Check and verify pump alignment and rotation.
 - b. Water systems shall be cleaned by circulation and strainers cleaned for normal operation.
 - c. Check each pump motor, amperage and voltage to ensure readings do not exceed nameplate rating.
 - d. Verify electrical overload heater elements to be of proper size and ratings.
 - e. All water circulating systems shall be full and free of air; all vents installed at high points of systems.
 - 3. All controlling instruments calibrated and set for design conditions.
- B. Tabulated Data. The motor amperages, voltages and overload heater size of each piece of electrically driven equipment, including exhaust fans, shall be recorded showing "actual" and "nameplate" data and submit to the owner prior to balancing.
- C. The Contractor and the suppliers of the equipment installed shall all cooperate with the TAB Firm to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or malperformance. Furnish a list of all motors with nameplate data and size of overload heater installed with motor amperage during operation.
- D. During the balancing the temperature regulation shall be adjusted for proper relationship between controlling instruments and calibrated by the Control Manufacturer using data submitted by the TAB Firm. The correctness of the final setting shall be proved by taking hourly readings for a period of 3 successive eight hour days, in a typical room on each separately controlled zone. The total variation shall not exceed 2 degrees from the preset medium temperature during the entire temperature survey period.
- E. In all fans systems, the air quantities shown on the plans may be varied as required to secure a maximum temperature variation of 2 degrees within each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drives, sheaves, belts, dampers, etc., and/or motors if necessary, without cost to the Owner, to attain the specified air volumes.

- F. The Contractor shall assist the TAB Firm in performing 3 inspections within 90 days after occupancy of the building to ensure that satisfactory conditions are being maintained throughout and to satisfy any unusual condition.

1.05 RESPONSIBILITY OF TAB FIRM

- A. The services of balancing, testing, and adjusting of the heating, ventilating, and air conditioning systems, including fume hoods and snorkels, will be performed by an independent technical firm or balancing company operating under the same firm name for five years with a minimum of five years specialized experience in the field of air conditioning system balancing, and possessing calibrated instruments, qualified Engineers, and skilled technicians to perform all required tests.
- B. The TAB personnel shall check, adjust, and balance the components of the air conditioning system including which will result in optimum noise, temperature, and air flow conditions in the conditioned spaces of the building while the equipment for the system is operating economically. Equipment to be tested includes, but is not limited to, all air handling units, fan coil units, terminal boxes, air devices, pumps, and exhaust fans. The TAB firm shall certify fume hoods per section 11 53 13 – B3-B9 Laboratory Fume Hoods and related products. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents, which is the responsibility of the project contractor. Variable air volume systems shall be balanced in accordance with NEBB Procedural Standard "Variable Air Volume System Procedures."
- C. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. Such tests shall be made as are deemed necessary by the Architect indicate the fulfillment of the contract. The TAB Firm shall then make available to the Architect such instruments and technicians as are required for spot checks of the systems.
- D. The TAB Firm will not instruct or direct the Contractor in any of the work. Any proposed changes or revisions in the work shall be submitted to the Architect/Owner in writing. The Architect/Owner will process the proposal as appropriate.
- E. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the owner shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.06 BALANCING SERVICES

- A. The TAB Firm, Architect/Engineer and Owner will inspect the installation of heating and cooling pipe systems, sheet metal work, temperature and other component parts of the heating, air conditioning, and ventilating systems. The inspection of the work will cover that part relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses.
- B. Upon formal notification of completion of the installation and start-up of the mechanical equipment by the Contractor, the TAB Firm will balance, test, and adjust the systemic components to obtain optimum conditions in each conditioned space in the building.
- C. The TAB Firm shall be responsible for inspecting, balancing, adjusting, testing, and logging the data on the performance of fans, all dampers in the duct systems, all air distribution devices, and the flows of water through all coils.

- D. Final Air Balance. When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +5% to +10% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:
1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
 2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required make any required changes.
 3. Ampere Readings: Measure and record full load amperes for motors.
 4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
 5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
 6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
 7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.
 8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +/-5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.
 9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.
 10. Maximum and minimum air flow on terminal boxes.
- E. Final Chilled and Heating Hot Water Balance. When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:
1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, +5%. Adjust balancing valves at pumps to obtain design water flow. Permanently mark the balanced position for each valve.
 2. Temperature Readings: Read and record entering and leaving water temperatures at each water coil. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.
 3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow

measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

4. Ampere Readings: Reading and record full load amperes for each pump motor.
- F. Testing of Temperature Control Systems. In the process of performing the TAB work, the TAB Agency shall:
1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
 2. Verify that all control devices are properly connected.
 3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
 4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
 5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes, and fire/smoke dampers.
 6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
 7. Observe the calibration of all controllers.
 8. Verify the proper application of all normally opened and normally closed valves.
 9. Observe the locations of all temperature sensors, carbon dioxide sensors and humidity sensors for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
 10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
 11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
 12. Verify that all controller setpoints meet the design intent.
 13. Check all dampers for free travel.
 14. Verify the operation of all interlock systems.
 15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.
 16. A systematic listing of the above testing and verification shall be included in the final TAB report.
- G. Vibration Test on Air Handling Units.
1. Procedures for Vibration Measurements:
 - a. Use a vibration meter meeting the following criteria:
 - 1) Solid-state circuitry with a piezoelectric accelerometer.
 - 2) Velocity range of 0.1 to 10 inches per second.
 - 3) Displacement range of 1 to 100 mils.
 - 4) Frequency range of at least 0 to 1000 Hz.
 - 5) Capable of filtering unwanted frequencies.
 - b. Calibrate the vibration meter before each day of testing:
 - 1) Use a calibrator provided with the vibration meter.
 - 2) Follow vibration meter and calibrator manufacturer's calibration procedures.
 - c. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
 - d. Perform vibration measurements after air and water balancing and equipment testing is complete.

- e. Clean equipment surfaces in contact with the vibration transducer.
 - f. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
 - 2. Location of points:
 - a. Fan bearing, drive end.
 - b. Fan bearing, opposite end.
 - c. Motor bearing, center (if applicable).
 - d. Motor bearing, drive end.
 - e. Motor bearing, opposite end.
 - f. Casing (bottom or top).
 - g. Casing (side).
 - 3. Test readings:
 - a. Horizontal, velocity and displacement.
 - b. Vertical, velocity and displacement.
 - c. Axial, velocity and displacement.
 - 4. Normally acceptable readings, velocity and acceleration.
 - 5. Unusual conditions at time of test.
 - 6. Vibration source (if non-complying).
- H. The TAB Firm will, fourteen (14) days prior to Final Air Balance Inspection, prepare seven (7) copies of the completed Test and Balance Report. The Report shall be complete with logs, data, and records as required herein and all logs, data, and records shall be typed, produced on white bond paper, and bound with staples and tape. The Report shall be certified and approved by the professional principle Engineer of the TAB Firm and his seal shall appear on the first page of each copy. Transmit one (1) copy direct to the Owner's Representative and the remaining six (6) copies to the Architect. The Architect will review and approve the report. Upon approval, two (2) copies will be submitted to the Owner's Representative and two copies transmitted to the Contractor.

1.07 STANDARDS

- A. The TAB Firm shall perform the services in accordance with the National Environmental Balancing Bureau (NEBB) standards and procedures including revisions to the date of the contract.

1.08 STORAGE

- A. Refer to Mechanical General Provisions, Section 23 0010. The Contractor shall provide the TAB Firm an area of ample size, conveniently located for storage of tools, equipment, and other items as required.

1.09 NOTIFICATION

- A. Systems shall be complete and in operational readiness prior to notifying the Owner that the project is ready for the services of the TAB Firm and the Contractor shall so certify in writing to the Owner that such a condition exists. Systems shall be complete and in operational readiness prior to notifying the Owner that the project is ready for the services of the TAB Firm and the Contractor shall so certify in writing to the Owner that such a condition exists.
- B. Should the Owner be not notified and the TAB work commenced and the systems are found to not be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by the Owner. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the notification to have been premature, all costs of the inspection and work previously accomplished by the TAB Firm shall be paid for by the Contractor. Furthermore, such items as are not ready for TAB services shall be completed, placed in operational readiness, and TAB services shall again be requested. Complete, operational readiness, prior to commencement of TAB services, shall include the work described in the paragraph "Responsibility of Contractor."

- C. Refer to General Provisions. The Contractor shall provide the TAB Firm an area of ample size, conveniently located for storage of tools, equipment, and other items as required.
- D. The TAB Firm shall perform the services in accordance with the National Environmental Balancing Bureau (NEBB) standards and procedures including revisions to the date of the contract.
 - 1. Perform variable volume system verification to assure the tem and its components track with changes from full flow to minimum flow.
 - 2. A systematic listing of the above testing and verification shall be included in the final TAB report.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 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.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section, Project Record Documents.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, 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, to verify that they are accessible, and their controls are connected and functioning.

- L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- M. Examine strainers for clean screens and proper perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine equipment for installation and for properly operating safety interlocks and controls.
- R. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- S. 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.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness 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.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in National Environmental Balancing Bureau (NEBB) Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 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 outside-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. Check for proper sealing of air duct system.

3.05 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 maximum set-point 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 outside-air dampers at minimum, and 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 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 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 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. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets 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 the final fan performance data

- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Balance systems similar to constant-volume air systems.
 - 2. Set terminal units and supply fan at full-airflow condition.
 - 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - 4. Readjust fan airflow for final maximum readings.
 - 5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 - 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 - 7. 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 as described for constant-volume air systems:
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 - 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 - 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 - 3. Set terminal units at full-airflow condition.
 - 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - 5. Adjust terminal units for minimum airflow.
 - 6. Measure static pressure at the sensor.
 - 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.06 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 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 expansion tank liquid level.
 - 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.

3.07 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have CV rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.08 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.09 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.

3.11 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure outside-air, wet- and dry-bulb temperatures.

3.12 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.13 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: +/- 5%.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.14 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. 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, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 1. Title page.
 2. Name and address of TAB firm.
 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 firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, 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.
- E. 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 outside, 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.

3.15 ADDITIONAL TESTS

- A. The Contractor shall assist the TAB Firm in performing 3 inspections within 90 days after occupancy of the building to ensure that satisfactory conditions are being maintained throughout and to satisfy any unusual condition.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

**SECTION 23 0700
INSULATION - GENERAL**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This Section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.
- B. All the ductwork and piping in pump rooms, mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork.

1.02 RELATED WORK

- A. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.
- B. Insulation. Refer to specific sections on individual insulation types.
- C. Section 09900 or 09901, Painting.

1.03 REFERENCE STANDARDS

- A. ASTM International (ASTM).
- B. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).
- C. North American Insulation Manufacturers Association (NAIMA).
- D. "National Commercial & Industrial Insulation Standards" – MICA Manual.
- E. National Fire Protection Association (NFPA).
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
- G. Underwriter's Laboratories (UL).
- H. Underwriter's Laboratories Environment (UL Environment).

1.04 FIRE HAZARD RATING

- A. All equipment, duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.
- B. Combustible materials installed in plenums shall be insulated with insulation that is listed and labeled for installation within a plenum and for the application over the combustible material.

1.05 QUALITY ASSURANCE:

- A. Applicator shall be a company specializing in insulation application with minimum 5 years' experience.
- B. Products shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds.
- C. Fiberglass products shall have a minimum of 20 percent recycled glass content certified and UL Validated.

1.06 SUBMITTALS

- A. Product Data. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer's installation instructions, list of materials and thickness for equipment scheduled.
- B. Samples. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.
- C. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Attachment and covering of heat tracing inside insulation.
3. Insulation application at pipe expansion joints for each type of insulation.
4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Removable insulation at piping specialties, equipment connections, and access panels.
6. Application of field-applied jackets.
7. Application at linkages of control devices.
8. Field application for each equipment type.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed under individual specification sections.

2.02 INSULATION

- A. Insulate in accordance with appropriate specification section.

PART 3 EXECUTION

3.01 COMMON INSULATION REQUIREMENTS

- A. All materials shall be delivered to the site shall be dry, undamaged and maintained in good condition throughout the progress of the project.
- B. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.
- C. Insulate valves, fittings, flanges and special items in accordance with appropriate specification section.
- D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any damage caused by the condensation.
- E. 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.
- F. 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.
- G. 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.
- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.
- J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- K. Keep insulation materials dry during application and finishing.
- L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- M. Install insulation with least number of joints practical.
- N. Where vapor barrier is indicated, seal joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating/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 coating/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.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

3.02 ACCESSORIES

- A. Installation of accessories such as jacketing, bands, adhesives, insulation shields, coatings, finishes, etc. is specified under individual specification sections.

3.03 PAINTING OF INSULATION

- A. Where indicated on the architectural construction documents, paint ductwork or piping in exposed areas, not including mechanical and equipment rooms. Do not paint insulation located in return air plenums.
- B. FSK Jacket. Prior to painting, wipe clean insulation with FSK jacket with a mild cleaning solution that will not leave a residue and allow to dry completely. Paint FSK jacket with oil based or solvent based paint in accordance with manufacturer's recommendations and as required in Specification 09 90 00.
- C. ASJ Jacket. Prior to painting, dry wipe clean insulation with ASJ jacket to remove dust and loose dirt. Paint ASJ jacket with water based (latex) paint in accordance with manufacturer's recommendations and as required in Specification 09 90 00.

END OF SECTION

SECTION 23 0713 EXTERNAL DUCT INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section provides for furnishing and the installation of external insulation on concealed and exposed ductwork, including single wall supply ductwork, outside air ductwork, and relief and return air duct work in non air conditioned spaces and other miscellaneous ductwork. It also includes insulating the tops of all supply diffusers.
- B. All the ductwork exposed to view in public spaces, in mechanical and pump rooms, crawl space and equipment rooms including all areas without ceilings is to be considered as exposed ductwork.
- C. Consider space above ceilings air conditioned if floor above is air-conditioned or if the space is a return air plenum. Consider exterior vertical chases and vertical chases leading to spaces not air-conditioned as un-air conditioned spaces.
- D. No lined ductwork is allowed on the project unless specifically noted on drawings or in the specifications.

1.02 RELATED WORK

- A. Section 23 07 00, Insulation - General.
- B. Section 23 31 13, Ductwork.

1.03 REFERENCES STANDARDS

- A. ASTM C 411 - Temperature Range.
- B. ASTM C 553 - Mineral Fiber Blanket and Felt Insulation.
- C. ASTM C 612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C 1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
- E. ASTM E 96 Procedure A - Jacket Vapor Transmission.
- F. ASTM E 119 – Standard Method of Fire Test of Building Construction and Materials.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fiberglass:
 - 1. CertainTeed.
 - 2. JohnsManville.
 - 3. Owens-Corning.
 - 4. Knauf Insulation.
- B. Ceramic Fiber
 - 1. A.P. Green
 - 2. Premier
 - 3. 3M
 - 4. Thermal Ceramics
 - 5. FyreWrap
 - 6. CertainTeed
- C. Flexible Elastomeric
 - 1. Armacell

2.02 INSULATION

- A. Type D1, Flexible Glass Fiber Insulation: Provide flexible glass fiber insulation; bonded with a formaldehyde free thermosetting resin, with factory-applied, reinforced foil scrim kraft (FSK) facing vapor barrier, 1.0- pound per cubic foot density. A "K" factor of 0.27 at 75°F mean is required. Shall comply with ASTM C553, Types I, II and III, ASTM C 1136, Type II and ASTM C1290, Type III.
- B. Type D2, Semi-Rigid Glass Fiber Insulation: Provide semi-rigid glass fiber insulation; bonded with a formaldehyde free thermosetting resin, adhered to UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum 2.5 pound per cubic foot density. A K factor of 0.24 at 75°F mean is required.
- C. Type D3, Rigid Glass Fiber Insulation: Provide rigid board glass fiber duct insulation; bonded with a formaldehyde free thermosetting resin, with integral, UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum density of 6 pounds per cubic foot. A "K" factor of 0.22 at 75°F mean is required. Shall comply with ASTM C 612, Type IA or IB.
- D. Type D4, Fire-Rated Insulation: Provide 1-1/2 inch thick, 6-pound density, ceramic fiber blanket, aluminum foil laminated on both sides, suitable for continuous temperatures of 1900°F. Insulation shall provide 2-hour fire rating and be suitable for zero clearances to combustibles at any location. Include installation and hanger support requirements in submittal.
- E. Type D5, Outdoor (Exterior) Duct Insulation: Provide closed cell flexible elastomeric insulation with 13-ply laminate exterior weatherproof membrane (including 6 plies of aluminum foil), minimum density of 3.0 pound per cubic foot. A K factor of 0.25 at 75°F mean is required. Insulation shall have 10 year warranty against UV light.

2.03 COATINGS AND ADHESIVES

- A. Glass Fiber Insulation
 - 1. Coating. Foster 30-80 or Childers CP-38 vapor barrier coating. Permeance shall be 0.05 perms or less as tested by ASTM E96, Procedure A at 47 mils dft or 0.08 perms or less as tested by ASTM F1249. Coating must comply with MIL-PRF-19565C, Type II and be QPL listed.
 - 2. Adhesive. Fosters 85-60 or Childers CP-127 adhesive. Product must comply with ASTM C916 and ASTM E84 25/50 requirements.
- B. Reinforcing Mesh. Fiberglass or polyester, 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10.
- C. Flexible Elastomeric.
 - 1. Adhesive. Armaflex 520 BLV Low VOC Adhesive, Foster 85-75 or Childers CP-82.
- D. Outdoor Insulation
 - 1. Foster 30-90 or Childers CP-35. White
 - 2. Adhesive. Armaflex 520 or Low VOC Spray Adhesive.

2.04 FACTORY-APPLIED JACKETS

- A. FSK Jacket: Aluminum foil, fiberglass reinforced scrim with kraft paper backing; complying with ASTM C 1136, Type II.

PART 3 EXECUTION

3.01 GENERAL

- A. Do not apply insulation until ductwork has been tested.
- B. Verify surfaces are clean, foreign material removed, and dry.
- C. Where trapeze hangers are used, provide strip of non-compressible insulation between ductwork and hanger. Refer to detail on drawings for additional insulation and saddle requirements.

3.02 FIRE SAFETY REQUIREMENTS

- A. Do not extend duct coverings through walls or floors required to be fire stopped or required to have fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources such as electric resistance or fuel-burning heaters.

3.03 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air ductwork.
 2. Indoor, exposed supply and outdoor air ductwork.
 3. Indoor, concealed or exposed return and exhaust ductwork located in nonconditioned spaces, including above ceiling on level 2 and within the shaft.
 4. Exterior Ductwork
 5. Return and exhaust ductwork in chases located on exterior walls.
 6. Lab exhaust ductwork up to 10 feet on both sides of a shaft penetration.
- B. Air Devices:
1. Supply Diffuser.
 2. Uninsulated Plenums on Slot Diffusers and Linear Bar Grilles.
- C. Items Not Insulated:
1. Indoor, concealed return air ductwork (in chases, above ceilings, except as noted above).
 2. Indoor, exposed return air ductwork (in chases, mechanical rooms except as noted above).
 3. Flexible connectors.
 4. Double wall ductwork.
- D. Definitions
1. Oval ductwork shall be insulated the same as round ductwork.
 2. Outside air duct shall be considered ductwork (or plenum) from louver or intake hood to air handling unit.
 3. Pretreated outside air shall be insulated the same as supply ductwork.

3.04 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. Provide insulation with minimum thickness and installed "R" values in accordance with ASHRAE Standard 90.1-2013 Tables 6.8 2A & B, but not less than thickness specified in this specification and as required to prevent condensation:

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply & Outside Air – Rectangular/Round (Hot, Cold, Combination)	Concealed Ductwork	D1	2"
Supply & Outside Air – Rectangular (Hot, Cold, Combination)	Exposed Ductwork	D3	2"
Supply & Outside Air – Round (Hot, Cold, Combination)	Exposed Ductwork	D2	2"
Air Devices	Where Scheduled	D1	1"
Return Air, Relief Air, and Exhaust Air – Rectangular/Round	Concealed, Where Scheduled	D1	1"
Return Air, Relief Air, and Exhaust Air – Rectangular	Exposed, Where Scheduled	D3	1"
Return Air, Relief Air, and Exhaust Air - Round	Exposed, Where Scheduled	D2	1"

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply, Return, Exhaust Duct	Outdoor Environment	D5	2"
Lab Exhaust Air	Shaft Penetrations	D4	3"

3.05 TYPE D1, FLEXIBLE GLASS FIBER INSULATION

- A. Insulation shall be wrapped, in accordance with manufacturer's recommendations, on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches.
- B. Adhere insulation to ductwork with 4 inch wide strips of adhesive at 8 inches on center. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.
- C. On circumferential joints, the 2 inch flange on the facing shall be stapled with outward clinching steel staples on 2 inch centers, and taped with a minimum 3-inch-wide strip of reinforcing mesh and vapor barrier coating. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.

3.06 TYPE D2, SEMI-RIGID GLASS FIBER INSULATION

- A. All exposed ductwork in public areas and mechanical rooms shall be wrapped in accordance with manufacturer's recommendations. Firmly butt all joints together and seal longitudinal laps of factory-applied vapor barrier jacket with adhesive. Cover butt joints with a 4 inch wide strip of factory-supplied vapor barrier jacket facing adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating and reinforcing mesh.

3.07 TYPE D3, RIGID GLASS FIBER INSULATION

- A. Exposed ductwork shall be covered with rigid board insulation in accordance with manufacturer's recommendations.
- B. Fill and point up all joints, perforations and exposed edges with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.
- C. Securely fasten insulation to metal surface with mechanical fasteners on 12 inch centers.
- D. Mechanical fasteners (weld pins) and discs or other approved fasteners may be used. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.

3.08 TYPE D4, FIRE-RATED INSULATION

- A. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. Install per manufacturer' recommendations. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.
- B. Insulate around access doors to maintain 2-hr rating and provide access to access door in accordance with manufacturer's recommendations.
- C. Where ducts penetrate walls and floors, maintain insulation through penetration. Annular space between insulation and penetration shall be sealed with firestop compound.
- D. The Contractor shall coordinate any special manufacturer's hanger requirements for ductwork with fire rated insulation with sheetmetal contractor. If hanger rods and angles do not meet manufacture's requirements for fire rating, insulate hanger supports per manufacturer's installation instructions.

3.09 TYPE D5, OUTDOOR (EXTERIOR) DUCT INSULATION

- A. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.
- B. Adhere insulation to clean, oil-free surfaces with adhesive.
- C. Seams must be installed in compression and sealed with adhesive, then covered with seal tape.
- D. Follow the insulation manufacturer's installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer's warranty requirements. The duct insulation shall be constructed from the bottom up, with the top insulation sized to extend over the side insulation.

3.10 STANDING SEAMS

- A. Insulate standing seams and stiffeners which protrude through insulation with 3-pound density, 1-1/2 inch thick, faced duct insulation, flexible blanket or rigid insulation to match duct insulation. As a vapor seal on exposed edges, use glass cloth with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

3.11 AIR DEVICES

- A. Insulate backside of diffusers and uninsulated plenums on slot diffusers as indicated in application schedule.
- B. All edges of insulation should be taped to diffuser backpan with pressure-sensitive aluminum foil tapes listed and labeled under UL 181A, Part I.

3.12 HEATING COILS

- A. Install insulation on terminal box heating coil casings same as specified for adjacent ductwork.

3.13 FIRE, FIRE/SMOKE AND SMOKE DAMPERS

- A. Insulation Installation at Fire Rated Wall and Partition Penetrations: Terminate insulation at fire, fire/smoke and smoke 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. Seal insulation to wall.
- B. Insulation Installation at Fire Rated Floor Penetrations: For penetrations through fire rated assemblies, terminate insulation at fire and fire/smoke damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches. Seal insulation to floor.

END OF SECTION

**SECTION 23 0719
PIPING INSULATION**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Piping insulation for Heating Water Piping within building envelope, other than Crawl Spaces and wet areas.
 - 2. Furnishing and installation of insulation.
 - 3. Jackets and accessories.

1.02 REFERENCES

- A. ANSI/ASTM C 195 - Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM- C 547 - Mineral Fiber Preformed Pipe Insulation.
- C. ANSI/ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.
- D. ASTM B 209 - Aluminum and Aluminum-alloy Sheet and Plate.
- E. ASTM C 449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

1.03 QUALITY ASSURANCE

- A. Applicator. Company specializing in piping insulation application with five years minimum experience.
- B. Materials. UL/ULC Classified per UL 723 or Flame spread/fuel contributed smoke developed rating of 25/50 in accordance with ASTM E84.

1.04 SUBMITTALS

- A. Refer to Specification 23 0700.
- B. Submit product data on insulating materials, including manufacturer's safety and installation instructions.
- C. Include product description, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Fiberglass (P1)
 - a. Owens-Corning.
 - b. JohnsManville.
 - c. Knauf Insulation
 - 2. Flexible Elastomeric (P2)
 - a. Armacell; AP Armaflex.
 - b. K-Flex USA.

2.02 INSULATION

- A. Type P1: Furnish fiberglass insulation, bonded with a bio-based, formaldehyde free thermosetting resin, with factory applied, all service reinforced vapor barrier (ASJ or ASJ+) jacket having integral laminated aluminum vapor barrier and self sealing labs (SSL or SSL+). Jacketing shall have a maximum water vapor permeance of 0.02 perms. Insulation shall be in accordance with ASTM C585, STM C411, ANSI/ASTM C 547 with a "K" factor of 0.23 BTU-in/hr-ft²-°F at 75°F. Insulation shall be certified by Greenguard Gold.
- B. Type P2. Furnish closed-cell expanded rubber materials complying with ASTM C534, Type 1 for tubular materials or ASTM C534, Type 2 for sheet materials. Insulation shall have a maximum "K" factor of 0.28 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

2.03 INSULATION SHIELDS AND SADDLES

A. Field Fabricated:

1. Use high compression strength Foamglas blocks (HLB 1600) that will support the bearing area at hangers and supports.
2. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 2 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.
3. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference.
4. Adhere metal shield to insulation so that metal will not slide with respect to insulation. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
2 1/2" and smaller	14	16
3" to 4"	14	16
6" to 12"	24	14
14" and larger	24	12

5. At Contractor's option, factory-made insulation shields may be provided as made by Anvil Fig 168, equivalent by Pipe Shields, Inc., or equal. Insulation should extend at least 1 inch beyond metal. Select proper shield for service and pipe span.
 6. For Type P2 insulation, contractor shall use factory-made insulation shields with a rigid inner core and exterior PVC cladding for use at supports. Insulation material shall be compatible with adjacent insulation and by the same manufacturer. Similar to Armafix EcoLight.
- B. Saddles: Fit piping 2 inches through 10 inches operating at high temperatures with Anvil Figure 161 through 164 protection saddles, or similar saddles of proper design for specified insulation thickness. Fit pipe sizes over 10 inches with Anvil Figure 163A through 165A or similar saddle as required by insulation thickness specified.
- C. All shields are to be secured by 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

2.04 JACKETS

- A. PVC Jackets: Provide molded or mitered covers for flanges, valves and fittings similar to PROTO or Johns Manville Zeston 2000.
- B. Canvas or Glass Jackets and Lagging Adhesive/Coating: UL listed treated cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers CP-50AMV1, Fosters 30-36 lagging adhesive or approved equal.
- C. Factory-Applied Jackets
1. ASJ+ - SSL+: ASJ+ jacket with Self-Sealing Advanced Closure System; complying with ASTM C 1136 Type I, II, III, IV and VII secured with self-sealing longitudinal laps and matching ASJ+ butt strips.
 2. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM 1136 Type I, II, III, IV and VII.
 3. ASJ: White, kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
 4. ASJ-SSL: ASJ with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.05 SEALANT, ADHESIVE AND FINISH

- A. Fiberglass - High Temperature (Above 100°F):

1. Furnish Childers CP-82 or Foster 85-20 to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 2. Finish: Furnish Childers CP-10/11 or Foster 46-50 weather barrier mastic with reinforcing mesh.
 3. Cement: Furnish Ryder One Coat on insulated fittings, flanges and valves.
 4. Primer and Finish. Furnish Childers CP-50A MV1 diluted 50% with water to prime cement prior to applying coating.
 5. Lagging Adhesive: Used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 Sealfas, Childers CP-50AMV1 Chil Seal or approved equal.
- B. Flexible Elastomeric
1. Adhesive: Furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75, or Childers CP-82 to seal longitudinal laps and to adhere butt joint covers.
 2. Finish: Furnish Armaflex WB or Foster 30-64 water based latex enamel finish.
- C. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10

2.06 FITTINGS

- A. Provide pre-molded fittings and elbows molded in two matching half sections of same insulation thickness as adjoining piping. As an alternative, provide mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs. No insert or blanket insulation allowed.

2.07 PRIMER

- A. Polyguard RG-CHW for surface temperatures less than 130F, RG-2400 LT for piping with surface temperatures between 130F and 250F. Application thickness shall be 25 mils.
- B. Global Encasement Rust Inhibition Primer. Application thickness shall be minimum 3 mils (dry)
- C. Sherwin Williams Pro-Cryl Universal Acrylic Primer. Application thickness shall be minimum 3 mils (dry).

2.08 ALUMINUM JACKET

- A. Piping. Furnish for finishing interior insulated pipe, a prefabricated jacket of ASTM B209 aluminum, 0.020 inch thick, with factory-applied 2-mil moisture barrier.
- B. Valves, Fittings and Flanges. Provide complete coverage of all valves, fittings and flanges, provide aluminum covers, 0.020 inch thick, ASTM B209 aluminum.
- C. Straps and Seals. Furnish 1 inch x 0.010 inch, ASTM B209 aluminum strapping and seals for applying aluminum jacket and covers to provide completely weather tight covering of all insulation including caps, flanges and end of lines.
- D. Metal Jacketing Sealant: Furnish 1/8" bead of Foster 95-44 or Childers CP-76 underneath all metal jacketing laps to prevent water entry on outdoor applications.

PART 3 EXECUTION

3.01 PIPE

- A. Pressure testing of piping systems shall be complete prior to application of insulation.
- B. Prior to insulating piping,
1. Remove all oil, grease, cutting oils, dirt and other contaminants. Use suitable solvents, steam cleaning with detergent, or freshwater wash with detergent. Follow with thorough freshwater rinse.
 2. Provide primer coat on all chilled and heating hot water steel piping in accordance with manufacturer's recommendations, to include field welds and over factory applied paint/coating, in total compliance with mechanical identification section and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation.

- C. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.
- D. Type P1 Fiberglass:
 - 1. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating vapor seal shall be formed between the vapor barrier jacket and the bare pipe by liberal application of the vapor barrier sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to an along 2 inches of the jacket.
- E. Type P2.
 - 1. Provide finish as specified on all insulation.

3.02 VALVES, FLANGES AND FITTINGS

- A. Low Temperature:
 - 1. Insulate all valves, flanges and fittings with molded fitting covers secured with wire. Thickness of insulation shall be equal to that adjoining piping.
 - 2. Finish with two coats vapor barrier coating reinforced with reinforcing mesh. The application shall provide a minimum dry film thickness of 37 mils.
- B. High Temperature:
 - 1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.
 - 2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
 - 3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with pre-molded fitting covers with a thickness equal to or greater than adjoining straight pipe. Finish with mastic reinforced with reinforcing mesh.
 - 4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
 - 5. Omit insulation on heating hot water flexible pump connectors or expansion joints.

3.03 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with two coats of vapor barrier coating and reinforcing mesh.

3.04 SHIELDS AND HANGERS

- A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.
- B. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.05 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations.

- C. In exposed piping areas, locate insulation and cover seams in least visible locations. For outdoor installations seal jacket lap with 1/8" bead of metal jacketing sealant underneath each lap to prevent infiltration of water beneath jacket. On horizontal piping place over lap at side of pipe arranged so that water will run off of jacket and not into seam lap.
- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Neatly finish insulation at supports, protrusions, and interruptions. Use 1-1/2 inch Type P2 insulation to insulate drains gauges, thermometers, and strainers.

3.06 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE standard 90.1-2013, but not less than thicknesses specified in this specification and as required to prevent condensation. Where multiple materials are listed for a single service and location, it is the Contractor's option to choose from the allowable insulations.

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Chilled Water	Interior		Refer to Section 23 0719.16	
AHU/FCU Condensate Drains	Interior	P2	All sizes	1
Heating Hot Water	Interior	P1	1-1/4" and smaller	1-1/2
Heating Hot Water	Interior	P1	1-1/2" to 4"	2
Heating Hot Water	Interior	P1	6" and larger	2-1/2
Supports, protrusions, drains, gauges, thermometers, suction diffusers and strainers	Interior/ Exterior	P2	All Sizes	1-1/2
Chilled and Heating Hot Water	Exterior		Refer to Section 23 0719.16	

3.07 ALUMINUM JACKET

- A. Apply aluminum jacket and covers according to manufacturer's recommendations, using aluminum strapping and metal jacketing sealant to provide completely weathertight covering. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
- B. Provide aluminum jacket for all piping within 84 inches of finished floor in air handler mechanical rooms, pump rooms, penthouses and exposed occupied spaces in the building. Do not install jacketing on AHU Condensate drains unless noted otherwise. Do not install jacketing on flexible pump connectors or expansion joints.

3.08 EXTERIOR JACKET

- A. Apply aluminum jacketing and covers according to manufacturer's recommendations. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
- B. Provide exterior jacket for all insulated piping located outdoors.

END OF SECTION

SECTION 23 0719.16
PIPING INSULATION (FOAMGLAS)

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Piping insulation for Exterior Chilled and Heating Water piping.
 - 2. Piping insulation for Chilled Water Piping within building envelope.
 - 3. Primary and Secondary chilled water piping shall be considered chilled water piping in these specifications.
 - 4. Furnishing and installation of insulation.
 - 5. Jackets and accessories.

1.02 REFERENCES

- A. ANSI/ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.
- B. ASTM B 209 - Aluminum and Aluminum-alloy Sheet and Plate.
- C. ASTM C 449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store materials (insulation, jacketing, sealant) in an area protected from the weather. Keep all materials dry before and during installation. Handle all materials carefully to prevent damage to insulation or jacketing.

1.04 QUALITY ASSURANCE

- A. Applicator. Company specializing in piping insulation application with five years minimum experience.
- B. Materials. Flame spread/fuel contributed smoke developed rating of 25/50 in accordance with ASTM E84.

1.05 SUBMITTALS

- A. Refer to Specification 23 07 00.
- B. Submit product data on insulating materials, including manufacturer's safety and installation instructions, and as required by Section 1.05D.
- C. Include product description, list of materials and thickness for each service, and locations.
- D. Product Data:
 - 1. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer's installation instructions, list of materials and thickness for piping scheduled.
 - 2. Submit insulation jacket surfaces temperatures by pipe size based on job site operating conditions. Indicate potential for condensing moisture on jacket.
 - 3. Refer to equipment schedules for fluid temperatures.
- E. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Insulation application at pipe expansion joints for each type of insulation.
 - 3. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Removable insulation at piping specialties, equipment connections, and access panels.
 - 5. Application of field-applied jackets.
 - 6. Application at linkages of control devices.
 - 7. Field application for each equipment type.

- F. Samples: Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. These specifications are based on products and data of Pittsburgh Corning Corporation and designate the type and quality of work intended under this Section. Products of other manufacturers proposed as equivalent quality must be submitted for written approval. Supporting technical data, samples, published specifications must be submitted for comparison. The Contractor should warrant that proposed substitutions, if accepted, will provide performance equal to the materials specified herein.

2.02 INSULATION

- A. Type P3: Foamglas One Insulation with a "K" factor of 0.29 BTU-In/Hr.-degree F at 75°F manufactured by Pittsburgh Corning Corporation and fabricated by a Pittsburgh Corning Corporation-approved fabricator. Water vapor permeability shall be 0.00 perm-in. The insulation shall comply with ASTM C 552 Type II, furnished in half sections up to 36 inches long or segments 18 inches long.

2.03 FLANGES AND FITTINGS

- A. Provide Foamglas One pre-molded insulation at flanges, valves, and fittings.
B. Provide fiberglass blanket insulation to fill small voids around flanges and valves as required.

2.04 INSULATION SHIELDS AND SADDLES

- A. Field Fabricated:
1. Use high compression strength Foamglas blocks (HLB 1600) that will support the bearing area at hangers and supports.
 2. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 2 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.
 3. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference.
 4. Adhere metal shield to insulation so that metal will not slide with respect to insulation. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
2 1/2" and smaller	14	16
3" to 4"	14	16
6" to 12"	24	14
14" and larger	24	12

5. At Contractor's option, factory-made insulation shields may be provided as made by Anvil Fig 168, equivalent by Pipe Shields, Inc., or equal. Insulation should extend at least 1 inch beyond metal. Select proper shield for service and pipe span.
 6. For Type P2 insulation, factory-made insulation shields such as Armafix IPH may be used at Contractor's option.
- B. Saddles: Fit piping 2 inches through 10 inches operating at high temperatures with Anvil Figure 161 through 164 protection saddles, or similar saddles of proper design for specified insulation thickness. Fit pipe sizes over 10 inches with Anvil Figure 163A through 165A or similar saddle as required by insulation thickness specified.
- C. All shields are to be secured by 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

2.05 JACKETS

- A. Provide aluminum jacketing meeting requirements of Section 23 0719.

2.06 BANDING

- A. Aluminum Steel bands, 1/2 inch wide by 0.0015 inch thick with matching seals.
- B. Reinforced tape for insulation, 3/4 inch with fiber reinforcement, Scotch Brand No. 880 by 3M, or equal.

2.07 SEALANT AND PRIMER

- A. FoamGlas:
 - 1. Sealant: Pittseal 444N Sealant by Pittsburgh Corning Corporation.
 - 2. Primer: Foster 60-26 or other rust-inhibitive primer.

PART 3 EXECUTION

3.01 PIPE

- A. Insulation shall be applied to piping with all joints tightly fitted to eliminate voids. For systems operating at or below 55°F, all joints must be sealed full-depth with sealant. Sealant shall not be used to fill voids or cracks.
- B. Insulation sections shall be secured with stainless steel bands. Two strips of reinforced tape may be used in place of bands or wire if exterior bands are used with jacketing. The tape shall overlap itself by 50 percent.
- C. Piping Outside of the Building Envelope: Aluminum jacketing shall be applied with all laps positioned to shed water and seams filled with silicone sealant. All laps shall be a minimum of 2 inches. Aluminum jacketing shall be secured using bands and seals as specified. Band spacing shall be two bands equally spaced per section of insulation. This will usually mean 9 inches or 12 inches on center.
- D. Insulate valves, flanges, and fittings in a manner similar to that for piping using materials in Part 2.
- E. Refer to 23 0719 for insulation requirements to insulate gauges, thermometers, strainers, and protrusions.

3.02 PREPERATION

- A. Tests of the piping system shall be completed prior to insulation application.
- B. All piping shall be cleaned of foreign substances and free of surface moisture prior to insulation application.
- C. All steel piping shall be primed with rust-inhibitive primer prior to insulating. Ductile iron piping shall have asphaltic coating on the exterior of the pipe.

3.03 CONTROL VALVE COVERS

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve.

3.04 SHIELDS AND HANGERS

- A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.

- B. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.05 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations.
- C. In exposed piping areas, locate insulation and cover seams in least visible locations. For outdoor installations seal jacket lap with suitable outdoor silicone sealant to prevent infiltration of water beneath jacket. On horizontal piping place over lap at side of pipe arranged so that water will run off of jacket and not into seam lap.
- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Neatly finish insulation at supports, protrusions, and interruptions. Refer to Section 23 0719 Piping Insulation (Fiberglass).

3.06 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE standard 90.1-2013, Table 6.8.3-1 and -2, but not less than thicknesses scheduled below.

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Chilled Water	Interior	P3	4" and smaller	2
Chilled Water	Interior	P3	6" and larger	2
Chilled Water	Exterior	P3	4" and smaller	2
Chilled Water	Exterior	P3	6" and larger	2
Heating Hot Water	Exterior	P3	4" and smaller	2-1/2
Heating Hot Water	Exterior	P3	6" and larger	2-1/2
Supports, protrusions, drains, gauges, thermometers and strainers	Interior/ Exterior		Refer to Section 23 0719	
Heating Hot Water	Interior		Refer to Section 23 0719	

3.07 ALUMINUM & EXTERIOR JACKET

- A. Provide jacket for all piping in accordance with requirements of Section 3 in Specification 23 0719.

END OF SECTION

**SECTION 23 0913
VENTURI LABORATORY TRACKING SYSTEMS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Furnish and install Air Valves for all laboratory spaces as shown on the drawings. The lab tracking system is to be integrated into the existing campus Building Automation System (BAS).
- B. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood. The system shall have the capabilities to provide constant face velocity control at either a standard / in use or a standby level based on an operator being present in front of the fume hood. The laboratory control system shall vary the amount of makeup/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The laboratory airflow control system shall be capable of operating as a stand-alone system, or as a system integrated with the Building Automation System (BAS).
- C. Installation of the air valves is by Division 23. Wiring and interface to the Building Automation System (BAS) is to be furnished by Division 23. Start-up and System Commissioning to be furnished by Division 23.

1.03 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Submit product data for valve electronic and electrical components and optional accessories. Each air valve model product name, and model ordering number, design air flow rates and differential pressure requirements across the valve.
- B. Record Documents:
 - 1. Submit complete point-to-point wiring diagrams for each applicable room configuration as shown on the Owner's Drawings.

1.05 WARRANTY

- A. Warranty shall commence upon the date of Owner acceptance and extend for a period of twenty-four months, whereupon, any defects in materials or system performance shall be repaired by manufacturer at no cost to the Owner.
- B. During the Warranty Period, if a service contract for the routine care, calibration, parts replacement, or upgrade of the system is required or recommended by the manufacturer, or such a contract is to be offered to the Owner during or after the Warranty Period, such contract and services shall also be included during the Warranty Period at no cost to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 ACCEPTABLE MANUFACTURERS

- A. Phoenix Controls Corporation (Basis of Design)
- B. Owner approved alternate

2.03 LABORATORY AIRFLOW CONTROL SYSTEM

- A. The Laboratory Airflow Control System (LACS) is a microprocessor-based airflow control system that is used for research laboratories and other critical room environments. The LACS shall have a BACnet interface for bi-directional communication with the BAS. The LACS shall provide data values, alarms, and set points used in each room-environment control scheme to the BAS, and also provide remote diagnostics and comprehensive reports and trends through the BAS.
- B. Each individual lab zone shall have a dedicated laboratory airflow control system. Each dedicated laboratory airflow control system shall support a minimum of twenty (20) network controlled airflow devices.
- C. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity over a minimum range of 20% to 100% of sash travel.
- D. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position with no more than 5% overshoot or undershoot of the required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.
- E. The hood exhaust airflow control device shall have the capability of automatically switching between in-use and standby levels based on operator presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from moment of detection with no more than a 5% overshoot or undershoot.
- F. The laboratory airflow control system shall maintain specific airflow (+/-5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change (within 0.3 inches to 3.0 inches w.c.), airflow change or quantity of airflow control devices on the manifold.
- G. The laboratory airflow control system shall use volumetric flow offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using room differential pressure measurement or velocity measurement to control room pressurization are unacceptable.
- H. The controller shall be integrated via BACnet with the following points as a minimum.
 - 1. Fume Hood Exhaust Flow (CFM).
 - 2. Supply/Make-up Airflow (CFM).
 - 3. General Exhaust Flow (CFM).
 - 4. Total Lab Exhaust Flow (CFM).
 - 5. Total Lab Supply Flow (CFM).
 - 6. Lab Airflow Offset (CFM,).
 - 7. Fume Hood Exhaust Low Flow Alarm.
 - 8. Fume Hood Sash Opening Percentage, Face Velocity, and Face Velocity Setpoint.
 - 9. Common Fume Hood Emergency Exhaust Alarm (Digital Contact).

10. Occupied, unoccupied, and emergency modes (command and status) of operation and associated command-able and adjustable points. (e.g., cooling and heating temperature setpoints (unocc/occ), different minimum supply airflow setpoints at various modes, lab airflow offset setpoint, etc.).
11. Valve static and low flow alarms.

I. The Control Unit shall also accept direct input signals from the BAS.

2.04 FUME HOOD CONTROLLER

- A. Linear controller shall be installed on the sash mullion of each hood and shall provide user interface/alarm functions and a linear control system, which translates the sash position into a proportional control signal to modulate the hood's exhaust air valve. Hood airflow shall be varied to maintain a nominally constant face velocity at the hood opening. Hood airflow shall be varied to maintain a constant face velocity over no less than a 5 to 1 change in the sash open area (change in sash position).
- B. Fume hood control system shall respond to and maintain the face velocity set point to ensure fume hood containment.
- C. Provide a fume hood controller to receive a sash position signal from the sash sensor, process this signal and then output an exhaust airflow control signal to the hood exhaust valve.
- D. The face velocity and minimum exhaust flow level of the fume hood shall be set at the fume hood monitor. Accurate adjustments of the face velocity shall be provided at the minimum and maximum sash positions.
- E. An emergency exhaust switch with an audible and dedicated visual alarm shall be provided on each fume hood monitor to override the sash sensor and command maximum exhaust airflow. Dedicated push to start, push to stop, pushbutton switches shall force the hood exhaust volume control device to its full flow position and force the supply valve to its specified minimum or maximum position.
- F. Fume hood controller shall have a visual and an audible enunciator to alarm the occurrence of a low face velocity. Muting of the enunciator will not cancel the visual alarm until the low flow condition is no longer present. The fume hood alarm shall be initiated by:
 1. A differential pressure switch located across a hood exhaust valve that senses a reduction in airflow of approximately 20 percent of set point.
 2. When the airflow value sent to the hood exhaust valve by the control unit is different than the actual airflow feedback value.
 3. The sash being raised above a specified height and/or specified area for fume hoods not sized for 100 percent opening.
 4. The alarm wire being disconnected.
- G. Fume hood controller shall include an LCD readout to indicate face velocity of hood; green LED indication for normal operation, yellow LED and audible alarm for an unsafe flow condition, yellow LED and audible alarm for night energy waste alert and red LED and audible alarm to indicate emergency exhaust operation.
- H. A pushbutton switch shall be provided to mute the audible alarms. The mute mode is automatically reset when the alarm condition ceases.
- I. Each of the flows and system "offset" shall be adjustable.
- J. A set of input contacts shall be provided inside the hood controller to remotely command the Emergency Exhaust mode from an external SPST contact.
- K. Momentary or extended losses of power shall not change or affect any of the control system's set points, calibration settings, or emergency exhaust mode status. After power returns the system shall continue operation exactly as before without need of operator intervention. Under no circumstances shall loss of power command the exhaust system to full flow upon return of power.
- L. Control power for the hood controller shall be provided from the supply air control panel.

2.05 FUME HOOD SASH POSITION SENSORS

- A. A sash sensor shall be provided to measure hood sash position and output a sash position signal to the hood controller. Sash position sensors shall be provided on vertical sashes. The sash sensor shall consist of a precision ten turn potentiometer mechanically coupled to a constant tension spring reel. A stainless steel, vinyl-coated cable shall be attached to the spring reel. Expected lifetime based on manufacturer's component data and tests shall be over 200,000 full height sash movements.
- B. A sidewall velocity sensor shall be provided for horizontal type sashes. Sash position sensor and sidewall velocity sensor shall be provided for combination type sashes.

2.06 AIRFLOW CONTROL DEVICES

- A. Venturi Control Devices
 - 1. The airflow control device shall be a venturi valve with an option for 100% shut-off capabilities. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2000. The valve body is constructed of 16 gauge spun aluminum with continuous welded seam, composite Teflon shaft bearings, and a spring grade stainless steel spring in the slider assembly. Supply valves to be insulated with 3/8" flexible closed cell polyethylene insulation material. Airflow devices have an operating range of 32-122° F ambient at 10-90% RH.
 - 2. The airflow control device shall be pressure independent over its specified differential static pressure operating ranges of 0.3"W.C – 3.0"W.C. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
 - 3. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range as shown in the table below and stated by the venturi's original manufacturer's sizing chart in the "Ideal Selection Range" without exceeding 2000 FPM velocity through any airflow device and have no deviation or loss of accuracy through the entire range of the flow device.

Pressure Drop Range	Airflow	Turndown	Valve Type
0.3- 3.0 in w.c.	Devices up to 550 CFM	11 to 1	Standard
Low Pressure	Devices up to 1,050 CFM	11 to 1	Standard

- 4. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
- 5. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range without exceeding 2000 FPM.
- 6. The airflow control device shall be constructed of one of the following three types or classes:
 - a. Class A – Body and cone of uncoated aluminum; shaft uncoated stainless steel.
 - b. Class B – Body and cone with phenolic coating; PFA coated stainless steel shaft. (For standard Fume Hood, Radioisotope Hood, and Biological Safety Cabinet applications)
 - c. Class C – Body, cone and hardware with phenolic coating; PFA coated stainless steel shaft. (For highly corrosive Fume Hood applications)
- 7. For two-position or VAV operation, an electric actuator shall be factory mounted to the valve. Loss of control power shall cause the actuator to fail in last position. When failed in last position, pressure independent airflow control is to be maintained by the airflow control device during power failure. Tracking pair low speed electric actuators fail in last position, but will continue to control air flow and be pressure independent with no power.
- 8. The controller for the airflow control devices shall be microprocessor based and operate using a peer-to-peer control architecture. The room-level airflow control devices shall function as a stand-alone network or can be fully integrated.

9. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each laboratory control system shall have the capability of performing; Fume hood control, Pressurization control, Temperature control, Humidity control, and implement Occupancy and Emergency mode control schemes.
10. The laboratory airflow control systems shall integrate digitally with the BAS through BACnet SIP Ethernet connect.
11. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least $\pm 1\%$ of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to $\pm 5\%$ of signal at a minimum of forty-eight different airflows across the full operating range of the device. All flow data for any given device shall be stored at the factory and be available on presentation of the unique serial number within 24 hours. Flow data for all valves shall be stored at a location away from the factory for disaster recovery purposes.
12. All airflow control devices shall be individually marked with device specific, factory calibration data. At a minimum, it should include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with record documentation
13. Valves will be selected and sized to not exceed the flow and pressure ranges in the following table:

Description	Size	Operating Range in CFM		Valve Type
		Single	Dual	
L- Low Pressure 0.3" – 3.0	8"	35 – 500		Standard
	10"	50 – 550	100 – 1100	Standard
	12"	90 – 1050	180 – 2100	Standard
	14"	200 – 1400	400 – 2800	Standard
L- Low Pressure 0.3" – 3.0	8"	35 – 400		Shut - Off
	10"	50 – 450	100 – 900	Shut - Off
	12"	90 – 900	180 - 1800	Shut - Off
	14"	200 – 1000	400 - 2000	Shut - Off

14. The shutoff airflow control device shall have shutoff and casing leakage of no more than:

Static Pressure Across Valve in Shutoff	Airflow	Shutoff Leakage	Casing Leakage
5.0 in w.c.	Shutoff devices up to 850 CFM	6 CFM	0.12 CFM/ ft ²
	Shutoff devices up to 1,300 CFM	6 CFM	0.12 CFM/ ft ²
	Low leakage shutoff devices up to 850 CFM	0.005 CFM	0.010 CFM/ ft ²
	Low leakage shutoff devices up to 1,300 CFM	0.010 CFM	0.010 CFM/ ft ²

15. 100% Shut-off sequence can be initiated through a universal input or remotely via the local area network from the BAS or a Local Display Unit. 100% Shut-off confirmation is available through a local digital output or an integrated point. The 100% shut-off confirmation is required by positive position verification.
16. Laboratory spaces that have chemical fume hoods requiring full high-speed actuator capabilities for proper VAV control shall use a system similar to the Phoenix CELERIS system. A system similar to the Phoenix CELERIS system with low speed electric actuation will be used for all Laboratory spaces (including spaces with two or more temperature sensors) with no fume hoods but have additional sequence requirements as noted by the schedules and/or sequence of operation.

2.07 CONTROL FUNCTIONS

- A. The airflow control devices shall utilize a peer-to-peer, distributed control architecture to perform room-level control functions. Master/Slave control schemes shall not be acceptable. Control functions shall at a minimum include, pressurization, temperature, humidity control and respond to occupancy and emergency control command.
- B. Pressurization Control
- The laboratory control system shall control supply and auxiliary exhaust airflow devices to maintain a volumetric flow offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
 - The pressurization control algorithm shall sum the flow values of all Supply and Exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable through the BAS.
 - The pressurization control algorithm shall support the ability to regulate the distribution of total supply airflow across multiple supply airflow control devices or total general exhaust airflow across multiple exhaust airflow control devices in order to optimize air distribution in the space.
- C. Temperature Control
- The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The laboratory control system shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five (5) temperature inputs and calculating a straight-line average to be used for control purposes. Separate cooling and heating set points for each occupancy mode shall be writable from the BMS, with the option of a local offset adjustment.
 - Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating shall be provided through modulating control of a properly sized reheat coil.

3. The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a stand-alone temperature control loop, or staged to supplement the corresponding primary temperature control loop.
- D. Occupancy Control
 1. The laboratory control system shall have the ability to change the minimum ventilation (supply airflow) and temperature control heating and cooling set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the BAS, as a scheduled event, or through the use of a local occupancy sensor or switch. The laboratory control system shall provide a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied, for a predetermined interval. The override interval shall be configurable for 1 to 1,440 minutes. The local occupancy sensor/switch, or bypass button shall be given priority over a BAS command.
- E. Airflow Shut-off Function
 1. The airflow control devices shown on the drawings and schedules as type SOV shall be capable of shut off function. Each device shall be capable of accepting a digital input to switch each individual air valve from the set point flow to shutoff position. This valve shall utilize an electric actuator with fail to last position operation. Feedback shall be available to indicate flow and shutoff. Confirmation of shut off shall be available through a digital output. These valves shall also be capable of network operation and being commanded to shutoff position from the BAS.

2.08 TERMINAL UNIT CONNECTIONS

- A. Venturi Valves
 1. Single valve terminal unit duct connections shall consist of round inlet connections suitable for flanged and bolted connection to rigid round duct as detailed on the Drawings. If circular bolt flanges are not noted on the drawings, then the Venturi Valve Draw band Clamp kit shall be utilized on both the inlet and outlet connections to the ductwork. Standard slip-in duct connections with sheet metal screws and sealer is not acceptable. Where multiple valves are employed, a common inlet plate suitable for slip connection to a single rectangular duct inlet duct shall be factory installed on the terminal unit using a press fit and silicone seal connection.

2.09 BAS INTEGRATION

- A. The room controllers shall be capable of direct communications with the existing BAS system via BACnet IP open protocol.
- B. The BAS shall be interfaced to allow remote monitoring of specified controller outputs and inputs and shall be capable of resetting room temperature set point.
- C. The BAS interface must be installed and fully operational before the control system will be accepted.
- D. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.

2.10 CONDUIT AND WIRING SYSTEM

- A. Cabling for these systems shall be either fiber optic, 24 AWG shielded twisted copper pair, or a mix of both. The Owner will consider exceptions to this requirement only if the laboratory tracking systems and constant volume valve manufacturer provides technical documentation, demonstrating that:
 1. This system will not function unless a different type of cable is used.
 2. The National Electrical Code requires cables to be shielded.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide a Project Manager, who shall, as a part of the Project Manager's duties, be responsible for the following activities:
 - 1. Coordination between the Contractor and all other trades, Owner, local authorities and the Architect/Engineer.
 - 2. Scheduling of manpower, material delivery, equipment installation, and checkout.
 - 3. Maintenance of construction records such as Project scheduling, manpower planning, and AutoCAD Drawings for Project coordination and Record Drawings.
- B. Calibration:
 - 1. Each Venturi airflow control valve shall be factory calibrated to the Project specific airflows as detailed on the Contract Documents. Valve shall be electronically calibrated / characterized at the factory by certified NIST traceable air stations. The valve's characterization shall be determined at eight (8) unique airflows including a test of the valve's pressure independence at three (3) different static pressures. A total of nineteen (19) airflow checks shall be performed and recorded for each air valve. All information shall be stored on a flash drive for future retrieval or for hard copy printout.
 - 2. Field adjustment shall not be required other than minor changes as required by the TAB Firm.
 - 3. Air shall be maintained plus or minus 5 percent of the design air quantity setting (subject to valve maximum and minimum CFM limits) over an inlet static pressure rate of 0.3 to 3.0 inches static pressure.

3.02 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Coordinate hood installation provisions with the project hood supplier.
- D. Coordinate the placement and installation of the sash position sensor with Project hood supplier or manufacturer.

3.03 SYSTEM START-UP AND TRAINING

- A. System start up shall be provided by a factory authorized representative of the laboratory airflow control system manufacturer. Start up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make up, general exhaust, or return).
- B. The balancing contractor shall be responsible for final verification and reporting of all airflows. All balancing shall be coordinated with the commissioning efforts of the BAS system.
- C. The laboratory airflow control system supplier shall furnish owner training, by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures. Refer to 017900.
- D. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

END OF SECTION

**SECTION 23 0923
DIRECT DIGITAL CONTROLS SYSTEM**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate electric meter data output connection to building energy management system.
- C. Coordinate connection to existing campus building energy management system.

1.02 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. The project shall be served by an approved control system matching existing campus system. This shall include new modules, sensors, control valves and actuators, damper actuators, wiring and graphics. Refer to the Drawings for reference and additional project requirements.
- C. Engage the services of one of the approved temperature control contractors to furnish and install the temperature control system as specified. The systems shall be direct digital control (DDC) BACnet compatible, and shall be complete including, but not limited to, control and instrumentation equipment, automation equipment, communication equipment, and supporting electric/electronic control installation. System shall be a turn-key installation, with components, system engineering, installation, programming and supervision provided by the approved manufacturer under a Temperature Control Sub-Contract.
- D. District has first right of refusal for any actuators. Coordinate with district's representative as required.
- E. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

1.03 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.

1.04 PROJECT REQUIREMENTS

- A. The Electrical Contractor shall provide 120-volt power in each mechanical room to a single point. Control and interlock wiring, both low-voltage and 120 volts, shall be by the temperature controls. Sub-contractor. Interlock wiring between fire alarm system shut down relays and mechanical system starters, VFD's and temperature controls devices shall be provided by the Temperature Controls Contractor. All wiring shall be run in conduit except plenum rated, low voltage wiring above accessible ceilings may be installed without conduit if installed near structure. All temperature controls wiring shall follow the applicable sections of Division 26. Controls contractor shall provide surge suppression (TVSS) protection for their equipment.
- B. The temperature control Sub-contractor shall provide complete control wiring diagrams and interlock wiring diagrams which have been approved by the Architect and shall provide on-the-job supervision for the wiring installation.

- C. After completion of the installation, EMS Contractor shall place the system in operation and shall perform all necessary testing and debugging operations of the EMS. This commissioning shall include point-to-point verification by the EMS Contractor on Owner approved forms.
- D. The temperature control system and its proper operation shall be guaranteed for a period of one year after substantial completion and any control devices which prove to be defective during the guarantee period shall be repaired or replaced without cost to the Owner. After the initial warranty period, an additional twelve months preventative maintenance contract shall be included in the base price of this Contract. This maintenance contract shall include quarterly preventive maintenance, all repair labor, parts and equipment. The system shall be warranted for parts and labor for a total of two years.
- E. The temperature control contractor shall furnish corrected copies of the final control wiring diagram and a letter stating that he has made final adjustments and instructed the Owner in the system operation at job completion.
- F. Provide a minimum of 2 hours of project system training on added/adjusted EMS components and systems.
- G. All setpoints, including time, temperature, humidity, pressure and flow, shall be adjustable.
- H. System shall be capable of transmitting data over fiberoptic cable, being accessed through the internet and through the school's internal network system via standard web browsers.
- I. Provide as-built drawings as a part of the online software for the building which shows the exact location of all installed equipment.

1.05 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. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.

- o. Carbon Monoxide: Plus or minus 5 percent of reading.
- p. Carbon Dioxide: Plus or minus 50 ppm.
- q. Electrical: Plus or minus 5 percent of reading.

1.06 SEQUENCE OF OPERATION

- A. See plans.

1.07 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. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
- F. 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.
- G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- H. Qualification Data: For Installer and manufacturer.
- I. Field quality-control test reports.
- J. 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.

1.08 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.
- 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. Comply with ASHRAE 135 for DDC system components.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

- H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- K. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- L. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Schneider Electric
 - 1) Contact: Chad Christman (210)216-1059
Email: chad.christman@se.com

2.02 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- 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. General Conditions:
 - 1. Contractor Responsibility: The BAS Contractor shall be fully responsible for the complete installation and proper operation of the Building Automation System equipment, sensors, controls, and controller. After the installation, the contractor shall be responsible for "debugging" and calibration of the BAS, including software for the duration of the warranty. All equipment shall be the latest standard design that complies with the specification requirements. During the warranty period, Contractor shall monitor system remotely and provide assistance to Owner in operational issues encountered. Should software control schemes provide unsatisfactory operation, as determined by the Engineer, during the warranty period, Contractor shall modify control schemes, setpoints, timing sequences or other software features to provide satisfactory operation as a part of his warranty package.
 - 2. System Architecture: The system shall possess fully modular architecture that permits the expansion of the system through the addition of field modules, sensors and actuators. Module communications to be through a local area network (LAN). The central site system shall be used only as an interface to the LAN.
- D. Graphic Construction:
 - 1. Space temperature and its deviation from zone setpoint shall be displayed on a floor plan map by color. These colors shall represent a defined temperature value and be implemented by the same standard throughout the entire system, including all graphic displays and parameter pages. The central site shall be able to display graphically, in up to 64 different colors, the following system information:

- a. General area maps shall show locations of controlled buildings in relation to local landmarks.
 - b. Floor plan maps shall display each piece of equipment relative to the floor with quick links to the respected individual equipment page. Floor plan maps shall show heating and cooling zones throughout the buildings in a range of colors which provide a visual display of temperature relative to their respective setpoints. The colors shall be updated automatically without operator action. Set point adjustment and color band displays shall be operator definable through the two-button mouse. Floor plan maps shall also show the relative position of sensors, exact location of mechanical rooms and AHU's, and all other mechanical equipment. Each zone shall display the setpoint temperature and measured space temperature.
 - c. Mechanical system graphics shall show the type of mechanical system components servicing any zone through the use of pictorial representation of components. It shall also provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate locations on the graphic representation of the setpoint and measured value.
 - d. All system graphics shall come programmed and require no owner modification. Individual graphics shall be as minimum the following:
 - 1) Each air handling unit
 - 2) Each zone of multi-zone
 - 3) Each single or double duct mixing box
 - 4) Updated chilled water piping system
 - 5) Updated hot water piping system
- E. Information Access: The following information shall be selectable from a pop-up menu within the graphics.
1. Alarms
 2. Message
 3. Module status
 4. Programming parameters
 5. Quit
 6. Schedules
 7. Temperature Reports
 8. Schedule Graphs
 9. Schedule Groups
 10. Setpoints
 11. Trends
 12. Utilities
 13. AHU report
 14. EF/SF Report
- F. Programming, scheduling and setpoint changes shall be accessible for modification of each menu for the associated equipment. Operator shall be able to automatically download changes from the central site to the appropriate program for the equipment being controlled. Operator shall be able to upload information from the field modules to the central site. In addition to having the ability to adjust setpoints on zones individually, the system shall allow the operator to make global setpoint changes that would take one command and automatically download it to the individual pieces of equipment and adjust their setpoints up or down by the operator defined deviation. A global command shall be able to be input that will automatically affect all installations connected to the network.
- G. Specific Graphic Requirements:
1. Data Format
 - a. Temperature Tenths xx.x °F
 - b. Percentage Units xx %
 - c. Amps Units xx A

- | | | | |
|----|--------------|-------|----------|
| d. | Humidity | Units | xx % |
| e. | Air Quantity | Units | xxxx CFM |
| f. | GPM | Units | xxx GPM |
2. Main Building Screen
 - a. Provide an overview of the entire building with color coding of zones based on temperature relative to setpoint, with light gray indicating zone is off. Green shall be area within setpoint tolerance, and varying shades of light to darker blue for lower than setpoint, and varying shades of light to dark red for higher than setpoint.
 - b. Clicking on an area of the building will change to a more detailed graphic of that area.
 - c. Provide table listing outside air temperature and RH percentage, and status for Fire Alarm, Emergency Generator and Air Conditioning Emergency Shutdown.
 - d. Provide button to click to go to equipment and mechanical systems graphics.
 3. Detailed Area Graphics
 - a. Individual zones shall be color coded base on temperature relative to setpoint, with light gray indicating zone is off. Green shall be area within setpoint tolerance, and varying shades of light to darker blue for lower than setpoint, and varying shades of light to dark red for higher than setpoint.
 - b. Label zone by AHU, AHU and Zone or AHU and CVT/VAV Box as applicable with zone temperature listed.
 - c. Clicking on zone cooling source or heating source shall transfer to applicable AHU or CVT/VAV box.
 - d. Provide button for each AHU serving this area that transfers to the AHU graphic.
 - e. Each piece of equipment shall be labeled and have a text indication whether it is ON, OFF or ALARM. Additionally, equipment that is on shall have some graphical indication of its status, either by color or animation. Animations shall be observable but not distracting. Status shall be based on equipment status sensors, not condition of the enabling point.
 4. Main Equipment Graphic
 - a. Provide composite graphic for the chilled water system at the central plant yard. The off/on condition of each chiller and pump shall be a color-coded element of the equipment: gray off, blue on, red failed. Additionally, equipment that is on shall have some graphical indication of its status by animation. Animations shall be observable but not distracting. Status shall be based on equipment status sensors, not condition of the enabling point.
 - b. Provide composite graphic for the heating water system. The off/on condition of each boiler and pump shall be a color-coded element of the equipment: gray off, blue on, red failed.
 - c. Provide buttons for each AHU and RTU that will transfer to the associated graphic.
 - d. Provide buttons for chilled water and heating water systems that transfer to the associated graphic.
 - e. Each data point shall be displayed adjacent to an appropriate graphical symbol located in the proper position in the system.
 - f. Each piece of equipment shall be labeled and have a text indication whether it is ON, OFF or ALARM. Additionally, equipment that is on shall have some graphical indication of its status, either by color or animation. Animations shall be observable but not distracting. Status shall be based on equipment status sensors, not condition of the enabling point
 5. Air Handling Unit Graphic
 - a. Provide graphic that shows all coils, valves and dampers. Outside air and return air shall be shown.

- b. Each piece of equipment shall be labeled and have a text indication whether it is ON, OFF or ALARM. Additionally, equipment that is on shall have some graphical indication of its status, either by color or animation. Animations shall be observable but not distracting. Status shall be based on equipment status sensors, not condition of the enabling point.
 - c. Each data point shall be displayed adjacent to a appropriate graphical symbol located in the proper position on the graphic. Include enable, alarm and status of each piece of equipment.
- 6. VAV Box
 - a. Provide individual graphic for each box and equipment.
 - b. Provide graphic that shows all coils, valves and dampers.
 - c. Each piece of equipment shall be labeled and have a text indication whether it is ON, OFF or ALARM. Additionally, equipment that is on shall have some graphical indication of its status, either by color or animation. Animations shall be observable but not distracting. Status shall be based on equipment status sensors, not condition of the enabling point.
 - d. Each data point shall be displayed adjacent to an appropriate graphical symbol located in the proper position on the graphic
- 7. Fans and Unit Heaters
 - a. Equipment with local/room thermostat shall have graphic noting state of unit and associated space temperature.
 - b. Fans associated with a particular air handling unit shall be a part of the air handling unit graphic.

2.03 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, anti-short cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).
 - 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- 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. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- 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 or 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.

2.04 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. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using BACnet IP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.05 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 1. Manufacturers:
 - a. Distech
 - b. JCI FX
 - c. Tasseron
 - d. Veris
 - e. Approved Equal
 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. 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.
 5. Averaging Elements in Ducts: Flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. Provide 1-0" of averaging element for each square foot of coil installed in a crossing pattern, and spaced so there are no gaps greater than one foot.
 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2- 1/2 inches.
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: white
 - e. Orientation: Vertical.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
 1. Manufacturers:
 - a. Distech
 - b. JCI FX
 - c. Tasseron
 - d. Veris
 - e. Approved Equal
 2. Accuracy: Plus or minus 0.2 percent at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. 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..
 5. 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.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: white
 - e. Orientation: Vertical.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- D. Humidity Sensors: Bulk polymer sensor element.
1. Manufacturers:
 - a. Distech
 - b. JCI FX
 - c. Tasseron
 - d. Veris
 - e. Approved Equal
 2. Accuracy: 5 percent full range with linear output.
 3. Room Sensor Range: 20 to 80 percent relative humidity.
 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: white
 - e. Orientation: Vertical.
 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg min.
 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- E. Pressure Transmitters/Transducers:
1. Manufacturers:
 - a. Distech
 - b. JCI FX
 - c. Tasseron
 - d. Veris
 - e. Approved Equal
 2. Static-Pressure Transmitter: Nondirectional 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 Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
 4. 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.
 5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Concealed.
 - 2. Set-Point Indication: Concealed.
 - 3. Thermometer: Concealed.
 - 4. Color: white
 - 5. Orientation: Vertical.
- G. Room sensor accessories include the following:
 - 1. Insulating Bases: For sensors located on exterior walls.
 - 2. Adjusting Key: As required for calibration and cover screws. 3.

2.06 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure- differential range of 8 to 60 psig, piped across pump.
- 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. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. 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.
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.

2.07 GAS DETECTION EQUIPMENT

- A. Manufacturers:
 - 1. Dywer
 - 2. ACI
 - 3. BAPI
 - 4. B. W. Technologies.
 - 5. CEA Instruments, Inc.
 - 6. Ebtron, Inc.
 - 7. Gems Sensors Inc.
 - 8. Greystone Energy Systems Inc.
 - 9. Honeywell International Inc.; Home & Building Control.
 - 10. INTEC Controls, Inc.
 - 11. I.T.M. Instruments Inc.
 - 12. MSA Canada Inc.
 - 13. QEL/Quatrosense Environmental Limited.
 - 14. Sauter Controls Corporation.
 - 15. Sensidyne, Inc.
 - 16. TSI Incorporated.

17. Vaisala.
 18. Vulcain Inc.
- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180- degree field of view with vertical sensing adjustment; for flush mounting.

2.08 FLOW MEASURING STATIONS

- A. Water Flow Meters (Chilled or Hot water)
1. Onicon insertion electromagnetic flow meter with System 10 BTU meter display (model F-3500)
 2. Materials of construction for wetted metal components shall be 316 SS.
 3. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter.
 4. Accuracy shall be within $\pm 1\%$ of rate from 2-20 ft/s.
 5. Overall turndown shall exceed 100:1.
 6. Output signals shall be completely isolated and shall consist of the following:
 - a. High resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter.
 - b. Analog output; 4-20mA, 0-10V, or 0-5V jumper selectable.
 - c. Scalable dry contact output for totalization.
 7. Each flow meter shall be covered by the manufacturer's two-year warranty.
- B. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
1. Manufacturers:
 - a. Ebtron
 - b. Paragon
 2. Casing: Galvanized-steel frame.
 3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
 4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.09 THERMOSTATS

- A. Manufacturers:
1. Distech
 2. JCI FX
 3. Schneider Electric
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
1. Label switches "FAN ON-OFF".
 2. Mount on single electric switch box.
- C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
1. Automatic switching from heating to cooling.
 2. Preferential rate control to minimize overshoot and deviation from set point.
 3. Set up for four separate temperatures per day.
 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.

5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap- switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set- point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 2. Selector Switch: Integral, manual on-off-auto.
- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 1. Bulbs in water lines with separate wells of same material as bulb.
 2. Bulbs in air ducts with flanges and shields.
 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 1. Reset: Manual.
 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- I. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- J. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

- K. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- L. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.10 HUMIDISTATS

- A. Manufacturers:
 - 1. Veris
 - 2. Dwyer
 - 3. Tasseron
 - 4. Approved Equal
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.11 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two- position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 4. 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. Manufacturers:
 - a. Belimo Air controls (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 non spring-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.

2.12 CONTROL VALVES

- A. Manufacturers:
 1. Belimo
- B. Control Valves: All control valves shall be provided by control contractor. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
 1. NPS 2 and Smaller: Class 125 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 Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. 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.
- D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 1. Body Style: Wafer.
 2. Disc Type: Nickel-plated ductile iron.
 3. Sizing: 1-psig maximum pressure drop at design flow rate.
- E. Self-Contained 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. Thermostatic Operator: -filled remote sensor with integral adjustable dial.

2.13 DAMPERS

- A. Manufacturers:
 1. Air Balance Inc.
 2. Ruskin
 3. TAMCO (T. A. Morrison & Co. Inc.).
 4. United Enertech Corp.

5. Vent Products Company, Inc.
- B. Dampers: AMCA-rated, parallel 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.

2.14 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

3.02 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, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 46 inches above the floor aligned with centerline of light switches.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- H. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."
- I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.03 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 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. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- F. Minimum conduit size shall be 3/4".

3.04 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. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. 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 instrument tubing for proper fittings, slope, material, and support.
 - 5. Check installation of air supply for each instrument.
 - 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 8. Check temperature instruments and material and length of sensing elements.
 - 9. Check control valves. Verify that they are in correct direction.
 - 10. Check 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.

3.05 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 and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.06 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

SECTION 23 2113 HYDRONIC PIPING AND FITTINGS

PART 1 GENERAL

1.01 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. Chilled-water piping.
 - 3. Condensate-drain piping.
 - 4. Air-vent piping.
- B. Related Specifications
 - 1. Section 23 05 19, Meters and Gauges, for HVAC Piping for thermometers and gauges.
 - 2. Section 23 05 23, General Duty Valves for HVAC Piping, for valves
 - 3. Section 23 05 29, Hangers and Supports, for hangers and supports.
 - 4. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
 - 5. Section 23 21 16, Hydronic Specialties, for hydronic specialties.

1.02 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe
 - 2. Fittings and accessories
- 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.
- C. Cleaning/Flushing Plan: This must be submitted and approved prior to any piping being installed. Plan, including all steps to be taken to ensure the piping installation will be cleaned properly prior to: service, circulation through equipment, or connection to another system. This shall include, but not be limited to:
 - 1. A step by step explanation of the process.
 - 2. Drawing(s) indicating flow (gpm) values required to meet the minimum velocity in each pipe.
 - 3. Drawing(s) indicating the phase(s) in which the system will be cleaned as required to ensure the minimum velocity will be maintained in each section of piping. It is expected that multiple phases will be required to achieve the minimum velocities in all of the piping safely.
 - 4. Drawing(s) indicating locations of the required temporary connections, valves, strainers, and bypasses.
 - 5. Cutsheet of the temporary pump to be used during flushing.
 - 6. Water treatment and pipe cleaning chemicals.
- D. Field quality-control test reports.
- E. Submit certification of welder's qualifications to perform the required welding operations.
- F. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. 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.
- B. Provide domestic manufactured piping and fittings.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions.
- B. Piping shall be shipped from the factory with capped ends and stored on supports off the ground with ends covered at all times to prevent nesting of insects, birds, and other animals. Any pipe found to be without end-caps or not raised off of the ground should be cleaned by the contractor prior to installation.
- C. Protect piping from accumulation of dirt and debris in and around piping/components.

1.05 OPERATION AND MAINTENANCE DATA

- A. Operation and maintenance manuals shall include the following information:
 - 1. The approved submittal with all approved items present (not a partial resubmittal)
 - 2. Chemicals used in cleaning, flushing, inhibiting, and final water treatment.
 - 3. Water quality test reports from the cleaning process.

1.06 ADDITIONAL GROOVED PIPING/FITTING REQUIREMENTS

- A. In addition to other applicable requirements in the Part 1 specifications, the following is required for grooved piping and fittings.
- B. Submittals – Grooved Fittings
 - 1. Victaulic products shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.
- C. Quality Assurance – Grooved Fittings
 - 1. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.
 - 2. A manufacturer's factory trained inspector (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The manufacturer's inspector will inspect installation. The contractor shall remove and replace any improperly installed products. Upon completion of the manufacturer's inspection of the installation, the manufacturer shall supply the owner with an extended 30-year product warranty. The warranty shall cover the cost of part and labor for repairing any leaking piping and joints.

PART 2 PRODUCTS

2.01 STEEL PIPING AND FITTINGS

- A. 2 inches and less in diameter. ASTM A 53, Grade B, schedule 80 seamless black steel pipe with schedule 80 malleable iron threaded fittings, satisfying ASTM B16.3 and ASTM A 197.
- B. 2-1/2 inches to 10 inches in diameter. ASTM A 53, Grade B, schedule 40 seamless or electric-resistance welded black steel pipe with schedule 40 seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.
- C. For pipe 12 inches and larger in diameter, provide schedule 40 pipe meeting the requirements of ASTM A53 or A106 Grade B seamless or ERW black steel pipe with schedule 40 seamless black steel welding fittings satisfying ASTM A 234 grade WPA or WPB, ANSI B16.9.

2.02 COPPER PIPING AND FITTINGS

- A. ASTM B88, hard drawn Type L seamless copper tube with wrought copper fittings, ASME B16.22.

2.03 JOINTS

- A. Screwed (Steel Piping, 2" and smaller):
 - 1. Make screwed joints using machine-cut ANSI taper pipe threads.
 - 2. Apply suitable joint compound, such as Teflon tape to the male threads only.
 - 3. Ream pipe to full inside diameter after cutting. All-thread nipples are not permitted.

- B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions.
 - 1. Provide insulating unions as manufactured by Crane, EPCO Sales, Inc. or approved equivalent.
- C. Solder Joints (Copper Piping):
 - 1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 - 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
 - 3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.
- D. Press Fittings
 - 1. At Contractor's option press fittings may be used with copper piping
 - 2. Allowable Manufacturers
 - a. Viega (Pro-Press)
 - 3. Joints may also be joining method with a non-toxic synthetic rubber elastomer seal (EPDM O-RINGS) with the fitting socket. The fitting shall be pressed under substantial pressure by RIDGID power tool forming a joint rated for 200 psi and tested for 600 psi,
 - 4. For piping 4" and smaller provide wrought-copper fitting with EPDM O-rings with fitting sockets. Fittings shall be pressed under pressure forming a joint rated for 200 psi and tested for 600 psi.
 - 5. Fittings shall have identification to indicate that a fitting is unpressed. Unpressed fittings shall leak under hydrostatic test.
- E. Welded (Steel Piping, 2-1/2" and larger):
 - 1. Make welded joints as recommended by the standards of the American Welding Society.
 - 2. Ensure complete penetration of deposited metal with base metal.
 - 3. Provide filler metal suitable for use with base metal.
 - 4. Keep inside of fittings free from globules of weld metal.
 - 5. Do not use mitered joints.
 - 6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
- F. Flanged:
 - 1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
 - 2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
 - 3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.
 - 4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use galvanized steel nuts and bolts underground, coated with tow coats of coal tar enamel. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.
 - 5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105 or ASTM A 108. Use welding neck type flanges at all fittings and on all pipe.
 - 6. Flanges for ductile iron pipe are specified in sections using that pipe.
 - 7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

2.04 GROOVED FITTINGS

- A. Acceptable Manufacturers: Victaulic Company of America
- B. Where allowed in application table in Part 3 of this specification, Victaulic press type fittings are allowed for piping 2 inches and smaller.
- C. Where allowed in application table in Part 3 of this specification, Victaulic grooved mechanical couplings are allowed for piping 2-1/2 inches and larger.
- D. Press Type Fittings:
 - 1. At Contractors option, 1/2" through 2" ASTM A312, Type 304/304L, Sch. 10S, pipe, dimensions conforming to ANSI/ASME B36.19M-1985 for chilled and heating hot water systems as indicated in the application table in Part 3.
 - 2. Vic-Press 304™: ASTM A-312 stainless steel housings with ASTM A-276 and A-312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "E" EPDM for applicable services to +250 Deg F. System shall be rated to 500 psi unless noted otherwise.
 - a. Flange Adapters: ANSI Class 150 flange adapter, Van Stone type with stainless steel back-up flange and Vic-Press™ ends. Rated for services to 275 psi. Victaulic Style P565.
 - b. Unions: Threaded union, 304/304L stainless steel, with Vic-Press™ ends. Victaulic Style P584.
- E. Grooved Mechanical Couplings:
 - 1. At Contractors option, roll or cut groove couplings, pipe, and fittings may be used in lieu of weld, flange or screwed joints for chill water and hot water systems where indicated in the application table in Part 3.
 - 2. All grooved end fittings shall be domestic made ductile iron conforming to ASTM A536; wrought steel conforming to ASTM A234. Grooved ends shall conform with AWWA C606. Adjoining couplings shall consist of two ductile iron housing segments, pressure-responsive gasket, and stainless steel bolts and nuts. Factory-fabricated fittings from steel pipe are not allowed. Branch connections must meet the requirements of steel piping called out in this specification, regardless if it is factory-fabricated or field-fabricated.
 - a. 2" through 12": Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F
 - 1) Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 107.
 - 2) Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Installation-Ready Style 177. Where Style 177 is not available in the pipe size required, use a Style 77 coupling.
 - b. 14" through 60": Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
 - 1) Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
 - 2) Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.
 - c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741.
- F. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)

2.05 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical, thermal, and pressure conditions of piping system contents and complying with ASME B16.21.
 - 1. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. For pipe smaller than 6 inches, use 1/16 inch thick gasket.
 - 2. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.
 - 3. Garlock or equal.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.06 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Unions (for connecting to equipment where OEM connection provided is plastic):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBI.
 - d. NIBCO INC.
 - 2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.07 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:
 - 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. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

2.08 UNIONS

- A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.09 BRANCH CONNECTIONS

- A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.
- B. For 2-1/2 Inches through 20 inches. For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weldolet when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.

2.10 FLOOR AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 EXECUTION

3.01 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 branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- N. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.
- O. Install valves according to the appropriate section.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- R. 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.
- S. Identify piping as specified in the above referenced specification section.
- T. Support piping adequately to maintain line and grade, with due provision for expansion and contraction.
- U. Use only long radius elbows on steel and copper piping unless a short radius elbow is specifically shown on the drawings.
- V. Slope condensate drain piping at a minimum 1/8 inch per foot in the direction of flow.
- W. Provide dielectric union or flange at connections of dissimilar metals, including equipment connections.

3.02 WELDING

- A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
- C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.03 OFFSETS AND FITTINGS

- A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.
- B. Install all piping close to walls, ceilings, and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.
- C. Install piping as to not obstruct any equipment or architectural access doors.

3.04 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor, at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.
- B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil. Refer to mechanical details for additional requirements.

3.05 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.
- B. Install 2 inch drain for 2 -inch pipes and larger.
- C. Install a line size drain valve for pipes smaller than 2 inches.
- D. Provide hose adapter and cap on all drain lines.

- E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.06 PIPE 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.
- E. 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.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.07 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 ports for pressure gages and thermometers at coil inlet and outlet connections according to the above referenced specification section. Refer to drawings for additional requirements.

3.08 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Provide service connections to items of equipment furnished by others:
 - 1. Detailed shop drawings of equipment shall be furnished indicated the exact number and location of rough-in points.
 - 2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
 - 3. Making adjustments to field conditions is considered a part of the work required.
- B. Roughing-In:
 - 1. When roughing-in, extend service piping to various items of equipment.
 - 2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
 - 3. Do not use contract drawings accompanying specifications for rough-in locations but for pipe sizing and general routing.
- C. Stop Valves:
 - 1. Provide stop valves for each service at rough-in locations, except for drains.
 - 2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.

3.09 CLEANING OF PIPING SYSTEMS

- A. Cleaning of piping system must be performed by the mechanical contractor. Cleaning chemicals, procedure, water testing, reporting, and consultation must be provided by a qualified water treatment company specializing in this type of work. Qualified water treatment vendor will have the following features.
 - 1. Operating in the business of industrial water treatment for minimum 5 years.

2. Certified to the ISO 9000 quality standard.
 3. Manufacture and deliver their own products.
 4. Provide technical specialist(s) for onsite water testing, reporting, and consultation.
 5. Have the ability to perform offsite analytical laboratory work and reporting if necessary.
- B. Acceptable vendors for chemical treatment should include, but not be limited to the following companies:
1. Kurita America (U.S. Water/ChemCal).
 2. GE Water & Process Technologies
 3. Nalco Company
 4. Design Controls, a Chemtron Company
- C. Minimum velocity of 10 feet per second for steel piping must be maintained in the pipes during flushing period.
1. Do not use building pumps for circulating water.
 2. Provide temporary pumps as required to achieve minimum velocities.
 3. Remove flow meters from building piping during flushing operation.
 4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
 5. For copper piping, maintain the flushing velocity between 3 (min) and 5 (max) feet per second. Limit temperature of water inside piping to a maximum 140°F.
- D. Submit a detailed plan for the Engineer's and Owner's review and approval describing in full detail the individual steps associated with this process before any piping is installed.
1. Refer to Submittal section above for further requirements.
- E. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating. Provide temporary relief valves to protect the piping system if recommended by the pipe cleaning subcontractor.
- F. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.
- G. Provide bypasses at the following equipment as close as feasibly possible to the equipment (no more than 10 feet total of piping at each piece of equipment) and isolate equipment as required (temporary blind flanges or similar):
1. Hydronic coils
- H. Chemicals shall remove mill scale, oil, and greases as well as passivate surfaces with a protective oxide film. NOTE: All residuals of the cleaning and passivating chemicals must be totally blown-down prior to system startup.
1. Alkaline cleaner/penetrant/dispersant chemical. This product must be in liquid form and capable of removing mill scale, oils, greases, debris, and byproducts of construction. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
 2. Passivating chemical. This product must be in liquid poly-phosphate form and capable of laying down a protective oxide film on metal surfaces after treatment with the cleaning chemical. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
 3. Antifoam chemical. This product must be in liquid form and capable of controlling or eliminating foam in water systems.
- I. Chemical for inhibiting and controlling corrosion and deposits must be added immediately after the chemical cleaning and passivating procedure.
1. Closed loop corrosion inhibitor chemical. This product must impart the following active ingredients at the following dosages when fed in the Chilled Water Loop water: 1) nitrite (as NO₂) = 400-800 ppm, 2) borate = 200-400 ppm, 3) azole = 20-60 ppm. This product

must impart the following active ingredients at the following dosages when fed in Heating Hot Water Loop water: 1) nitrite (as NO₂) = 800-1200 ppm, 2) borate = 400-600 ppm, 3) azole = 40-80 ppm.

- J. Circulate chemical cleaner and passivator in closed loop water piping systems to remove mill scale, grease, oil, and silt.
 - 1. Flush and drain loops to remove debris prior to using chemicals.
 - 2. Fill loops and add chemical cleaner and passivator at the dosage rates recommended by the water treatment vendor based on system volume.
 - 3. Add antifoam at the dosage rates recommended by the water treatment vendor.
 - 4. Circulate water for 24-72 hours.
 - 5. Drain and flush system.
 - 6. Dispose of circulated water with chemical residuals as per local code requirements.
 - 7. Refill and immediately charge with the proper corrosion inhibitor – based on the type of piping system – to the recommended level.
 - 8. Match chemicals presently used in other systems used by Owner if possible.
 - 9. Submit all chemicals to Owner and Engineer prior to cleaning for approval.
 - 10. Match chemicals presently used in other systems used by Owner.
 - 11. Provide report comparing make-up water quality to the water circulated in the pipe after cleaning chemicals are removed. Report shall include the following at a minimum:
 - a. Conductivity
 - b. Ph
 - c. phosphate
 - d. Iron
- K. Special requirements, if any, are specified in the appropriate Sections for each type of piping.
- L. After systems have been flushed and cleaned; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use. This shall include the water quality report comparing the make-up water to the water circulated in the piping after removal of chemicals to verify pipe condition.

3.10 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, minimum 150 psig. 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. Verify lubrication of motors and bearings.

3.11 PIPING APPLICATION SCHEDULE

- A. Provide piping and fittings meeting the requirements of Part 2 as identified in the table below:

Service	Pipe Sizes	Pipe Material
Chilled Water Piping	2" and smaller	Copper
Chilled Water Piping	2-1/2" – 4"	Steel
Chilled Water Piping	6" – 24"	Steel
Heating Hot Water Piping	2" and smaller	Copper
Heating Hot Water Piping	2-1/2" – 4"	Steel
Heating Hot Water Piping	6" – 14"	Steel
Condensate Piping	All	Copper
Air-vent Piping	All	Copper, Steel
Safety-valve inlet and outlet piping	All	Same as for piping system for which it is installed

3.12 GROOVED END APPLICATION TABLE

- A. Grooved end piping and fittings are allowed on this project in the locations identified in the application table below:

Service	Location	Pipe Sizes
Chilled & Heating Hot Water Piping	All	All

END OF SECTION

**SECTION 23 2116
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes hydronic specialties, including the following:
 - 1. Air Vents.
- B. Related Specifications
 - 1. Section 23 05 19, Meters and Gages for HVAC Piping
 - 2. Section 23 21 13, Hydronic Piping and Fittings.

1.02 SUBMITTALS

- A. Product Data:
 - 1. Submit Shop Drawings and product data, including component sizes, rough-in requirements, service sizes, and finishes.
 - 2. Submit manufacturer's installation instructions.

1.03 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by the same manufacturer throughout

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment, etc. before installation in accordance with manufacturer's written instructions.

1.05 OPERATION AND MAINTENANCE DATA

- A. Operation and maintenance manuals shall include the following information:
 - 1. The approved submittal with all approved items present (not a partial resubmittal)

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

- A. Automatic Air Vents: Armstrong, APCO, Xylem Bell & Gossett
- B. Water Relief Valves: Keckley, Watts, Xylem Bell & Gossett

2.03 AUTOMATIC AIR VENTS

- A. Furnish and install cast iron body fixed pivot ball automatic float-type air vents at high points of all hydronic systems and where shown on drawings. Vent body shall be cast iron, with stainless steel float, and stainless steel seat, valve and lever. Vent shall be rated for a minimum of 125 psi, 250°F.

2.04 WATER RELIEF VALVES

- A. Pressure relief valves installed for the protection of the water circulating circuits shall be single seated diaphragm and spring type valve with screwed connections, similar to Watts No. 174A.
- B. 3/4 inch size of bronze construction with bronze seat, composition shut-off disc, and rubber diaphragm.

PART 3 EXECUTION

3.01 PREPARATION

- A. Flush and clean expansion tanks prior to delivery to the Project Site, and keep sealed during construction.

3.02 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.
- D. Provide valved drain and hose connection on strainer blow down connection.
- E. Support pump fittings with floor mounted pipe and flange supports.
- F. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and where shown on details.
- G. Select system relief valve capacity so that capacity is greater than make up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- H. Pipe relief valve outlet to nearest floor drain.
- I. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- J. Align flanges between equipment and piping prior to making connections. Piping should never be drawn into place by force.
- K. Air Vent
 - 1. Provide air vents at the highest points of the hydraulic piping systems and on the uppermost connections to all hydraulic coils. Provide shutoff valves to facilitate maintenance of air vents.
 - 2. Locate all air vents and their discharge lines in accessible locations, preferably clustered.
 - 3. For automatic air vents in above-ceiling spaces or other concealed locations, extend vent tubing to nearest drain
 - 4. Route ½-inch discharge lines to nearest floor drain without air traps.

END OF SECTION

SECTION 23 3113 DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation
- B. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Oval ducts and fittings.
 - 4. Fume hood ductwork.
 - 5. Wet Exhaust Ductwork. (Autoclave, etc)
 - 6. Sheet metal materials.
 - 7. Sealants and gaskets.
 - 8. Hangers and supports.
- C. Related Sections:
 - 1. Division 09 Section, Painting, for interior painting of metal ductwork exposed to view through grilles, registers, and other openings.
 - 2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, for testing, adjusting, and balancing requirements for metal ducts.
 - 3. Section 23 07 13, External Ductwork Insulation.
 - 4. Section 23 33 00, Ductwork Accessories, for dampers, spin-in fittings, flexible duct connections.
 - 5. Section 23 34 13, Fans.
 - 6. Section 23 36 00 Air Terminal Units
 - 7. Section 23 37 13, Air Devices.

1.02 DEFINITIONS

- A. Low Pressure: Up to 2 inches w.g. positive or negative static pressure and velocity equal to 1500 fpm. Constructed and tested for +2 inches W.G.
- B. Medium Pressure: Over 2 inches w.g. through 6 inches w.g. positive or negative static pressure and velocity greater than 1500 fpm. All medium pressure ductwork shall be constructed and tested for +6 inches w.g.
- C. High Pressure: Over than 6 inches w.g. positive static pressure and velocity greater than 2500 fpm.
- D. Duct Size. The supply, return and exhaust duct sizes shown on drawings are clear inside sheet metal dimensions. Include proper allowances for acoustical lining, where indicated in plans or specifications. For acoustical return air boots, refer to additional information on detail.

1.03 GUARANTEE

- A. Guarantee all ductwork for 1 year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

1.04 CONTRACTOR COORDINATION

- A. Erect all ducts in the general locations shown on the drawing(s), but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor to check the physical conditions at the job site and make all necessary changes in cross sections, offsets and similar items, whether they are specifically indicated on drawing(s) or not. Do not obstruct the induced air plenum opening at VAV boxes and service access spaces for VAV boxes and other equipment.
- B. 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. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1.05 STANDARDS AND CODES

- A. Except as otherwise indicated, sheet metal ductwork material, fabrication and installation shall comply with Third Edition (2005) of SMACNA HVAC Construction Standards Metal and Flexible, except where indicated otherwise. All air distribution devices (such as dampers) included in this Section shall comply with the Third Edition (2005) of SMACNA HVAC Construction Standards Metal and Flexible.
- B. In addition, construct ductwork and all air distribution devices to the following:
 - 1. IMC International Mechanical Code
 - 2. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - 3. NFPA 90B Installation of Warm Air Heating and Air Conditioning Systems
 - 4. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements
 - 5. SMACNA Round Industrial Duct Construction Standards
 - 6. SMACNA The Managers' Guide for Welding

1.06 SUBMITTALS

- A. Product Data
 - 1. Submit product data for each product. Refer to Section 23 00 10.
 - 2. Provide acoustical data on insulated flexible ductwork as indicated in Part 2.
- B. Delegated-Design Submittal. Include the following for each system furnished on the project.
 - 1. System name and type
 - 2. Duct system design pressure.
 - 3. Sheet metal thicknesses and materials.
 - 4. Reinforcement details and spacing.
 - 5. Seam and joint construction and sealing.
 - 6. Fittings, construction and details.
 - 7. Hangers and supports, including materials, fabrication, methods for duct and building attachment.
 - 8. Provide detail of breakaway connections for fire, fire/smoke and smoke dampers for review.
 - 9. Submit specified edition of SMACNA HVAC Construction Standards Metal and Flexible - Duct Reinforcement Tables for specified ductwork types/systems and pressures with any deviations marked on associated SMACNA table.
- C. Ductwork shop drawings. Provide CAD-generated shop drawings of mechanical rooms and building ductwork drawn at a minimum scale of ¼ inch per foot. Include the following as a minimum:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory and shop fabricated duct and fittings.
 - 3. Duct layout indicating sizes, configuration and pressure classes.
 - 4. Elevations of top and bottom of ducts.

5. Dimensions of main duct runs from building grid lines.
 6. Reinforcement and spacing.
 7. Penetrations through fire-rated and other partitions.
 8. Equipment installation based on equipment being used on Project.
 9. Duct accessories, including access doors and panels, fire dampers and smoke dampers.
- D. Samples.
1. Provide a sample of stainless steel welded duct joint to Engineer and Owner for approval. Submit sample prior to duct fabrication. After approval, the sample shall remain at the jobsite for reference.
- E. Welding certificates. For duct welders including procedures and standards of acceptance.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Insulated Flexible Duct. Peppertree Air Solutions, Thermaflex, Flexmaster.

2.02 APPLICATION

- A. Ductwork shall be constructed in accordance with the following as a minimum. Refer to drawings for any deviations from this table.

SYSTEM	MATERIAL	MINIMUM PRESSURE CLASSIFICATION ⁽¹⁾
Supply Systems:		
All ductwork downstream of terminal boxes	Galvanized Steel	Low Pressure
All fan coil unit supply ductwork	Galvanized Steel	Low Pressure
Supply ductwork downstream of single zone VAV AHUs ⁽²⁾	Galvanized Steel	Medium Pressure
Connection to Air Device	Flexible Duct	As Specified
Return Systems:		
All fan coil unit return ductwork	Galvanized Steel	Low Pressure ⁽⁵⁾
Laboratory Exhaust Systems⁽⁷⁾:		
General lab exhaust - air device to General Exhaust valve	Galvanized Steel	Low Pressure ⁽⁵⁾
General lab exhaust – General Exhaust valve to exhaust fan	Galvanized Steel	Medium Pressure ⁽⁵⁾
Lab exhaust – Hood/BSC to Lab Exhaust valve	304 Stainless Steel	Medium Pressure ⁽⁵⁾
Lab exhaust –Lab Exhaust valve to exhaust fan	Galvanized Steel	Medium Pressure ⁽⁵⁾
Miscellaneous Exhaust Systems:		
Autoclave exhaust – air device to exhaust valve	316L Stainless Steel	Medium Pressure ⁽⁵⁾

- B. Notes to Table:
1. Positive pressure unless noted otherwise in Table.
 2. From air handling unit (AHU) to terminal boxes.
 3. From pretreatment AHU to AHU.
 4. Runout from air device to return/exhaust air trunk duct
 5. Negative pressure SMACNA table.
 6. Verify minimum pressure classification per NFPA 96 requirements.

7. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.

2.03 DUCT MATERIAL AND CONSTRUCTION

- A. General. Noncombustible or conforming to requirements for Class I air duct materials or UL 181. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein
- B. Galvanized Steel Ducts. Constructed of G-60 coated galvanized steel meeting requirements of ASTM A 653 or ASTM A 527. Stencil coils of sheet steel throughout on 10 foot centers with gage and manufacturer's name. All materials associated with the duct system shall be galvanized steel including stiffeners, fasteners, etc.
- C. Stainless Steel Ducts. Type 304 or 316L as indicated in application schedule. For round ductwork, butt-welded (solid welded) longitudinal seam only. Spiral lockseam and Spiral lockseam with standing rib is not acceptable.
- D. Fasteners. Rivets, bolts or sheet metal screws.
- E. Sealant.
 1. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Foster 32-19, Childers CP-146, Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.
 2. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count.
- F. Hangers and Supports.
 1. Support ductwork with continuously threaded hanger rods of galvanized steel or 20 gauge straps as indicated in these specifications.

2.04 RECTANGULAR DUCTS AND FITTINGS GENERAL REQUIREMENTS

- A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage for low pressure ductwork, 24 gage for medium pressure ductwork.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 2-1, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 2-2, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Snaplock longitudinal seams (L2) are not acceptable.
- D. Fittings:
 1. Select types and fabricate according to SMACNA Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
 2. Construct bends and elbows per SMACNA Figure 4-2, "Rectangular Elbows", Type RE1 with radius of not less than 1-1/2 times width of duct on centerline. Where not possible or where indicated on construction documents, construct Type RE2 rectangular elbows with welded-in-place double wall airfoil turning vanes (whether specifically shown on drawings or not), short radius type RE1 radius elbows, or type RE3 short radius elbows (radius 1 time width of duct on centerline) with single turning vane.
 3. Construct tees per SMACNA Figure 4-5, "Divided Flow Branches", Type 2, Type 3, Type 4A or 4.
 4. Construct branch connections per SMACNA Figure 4-6, "Branch Connection". Use 45 degree entry, 45 degree lead in, conical or bellmouth connections only.

5. Unless indicated on construction document details, transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence. Divergence upstream of equipment shall not exceed 30 degrees. Convergence downstream of equipment shall not exceed 45 degrees.
6. Bullhead tees are not permitted.

2.05 ROUND AND OVAL DUCTS AND FITTINGS GENERAL REQUIREMENTS

- A. General Fabrication Requirements: Comply with SMACNA Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-1, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Use flanged joints for ducts larger than 48 inches in diameter.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-2, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize spiral seam (RL-1) or butt weld seams (RL-4) only. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- D. Fittings:
 1. Fittings shall have a wall thickness not less than that specified for longitudinal-seam straight duct or 26 gage, whichever is more stringent.
 2. Tees and Laterals: Select types and fabricate according to SMACNA Figure 3-5, "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. Utilize 90 degree tee with oval to round tap, 45 degree lateral tap, or conical fitting only. Wye fittings may be utilized where specifically indicated on drawings and details.
 3. Elbows: Select stamped or segmented/gored elbows according to SMACNA Figure 3-4. Construct elbows with radius of not less than 1-1/2 times width of duct on centerline. Provide minimum 5 gore elbows on all 90 deg elbows, 3 gore elbows on 45 degree elbows. Continuously welded stamped long radius elbows may be utilized on ductwork up to and including 12-inches in diameter.
 4. Bullhead tees are not permitted.

2.06 INSULATED FLEXIBLE DUCTWORK

- A. Use for connection to diffusers and grilles as indicated in specifications and details.
- B. Construct the inner liner of coated steel helix and a PE or CPE liner substantially bonded together to prevent the duct from collapsing or kinking in short radius bends. Provide fiberglass insulation providing minimum R-4.2 thermal conductance and 3 pound minimum density around inner jacket consisting of fiberglass reinforcement and aluminum foil vapor barrier outer jacket. Use duct rated at minimum working pressure of 10 inches of water positive and 1 inches of water maximum negative pressure (4-12 in I.D.), and 6 inches of water positive and 1/2 inch of water maximum negative pressure (14- 16 I.D.). Provide duct listed by U.L. at flame spread rate of not over 25 and smoke developed rate of not over 50, and complying with NFPA Standard 90A and 90B. The entire assembly shall be listed by Underwriters Laboratories under U.L. Standard 181 as a Class I flexible air duct. Supplier shall submit laboratory test results indicating acoustical performance comparable to that of "Flexmaster Type 1M-Insulated".

2.07 STAINLESS STEEL DUCTWORK (LAB EXHAUST)

- A. Applies to stainless steel ductwork indicated in specification application table for Laboratory Exhaust Systems.
- B. Provide a welded sample for approval to the engineer and Owner.
- C. Provide exhaust ductwork of minimum gages:

DUCT SIZE	GAGE
28-inch diameter or less	18
30-inch to 60-inch diameter	16
61-inch diameter or greater	14
Greater than 60 x 42 (rectangular or oval)	Comply with SMACNA

- D. ALL LAB EXHAUST DUCTWORK SHALL HAVE LONGITUDINAL BUTT ("SOLID") WELD SEAMS WITH BUTT WELD JOINTS. Butt-weld all joints and fittings using Gas Tungsten Arc Welding ("TIG"). Welding procedures shall meet the requirements of SMACNA's The Managers' Guide for Welding. Welds on exposed ductwork inside the building shall be ground and polished. Duct sealant shall not be used to seal ductwork.
- E. Provide required transitions from duct to equipment and make equipment connections as indicated on details.
- F. Fittings:
 - 1. Refer to Round and Oval Ducts and Fittings General Requirements in this specification. Transverse and longitudinal seams shall be butt welded joints.
 - 2. Refer to drawings for additional information.
- G. Submit upon request by owner or A/E, certification of welder's qualifications to perform the required welding operations and all project WPS for TIG welding sheet metal. All welder certifications shall be maximum 2 years prior to project notice to proceed date.

2.08 STAINLESS STEEL DUCTWORK (WET EXHAUST)

- A. Applies to Autoclave exhaust ductwork indicated in specification application table and where indicated on drawings.
- B. Provide a welded sample for approval to the engineer and Owner.
- C. Provide and construct exhaust ductwork for rectangular ducts and fittings meeting the requirements under Rectangular Ducts and Fittings General Requirements in this specification. Provide and construct exhaust ductwork for round and oval ducts and fittings meeting the requirements under Round and Oval Ducts and Fittings General Requirements in this specification.
- D. All stainless steel exhaust ductwork shall have welded longitudinal seams and welded transverse joints. Welding procedures shall meet the requirements of SMACNA's The Managers' Guide for Welding. Welds on exposed ductwork inside the building shall be ground and polished. Duct sealant shall not be used to seal ductwork.
- E. Provide required transitions from duct to equipment and make equipment connections as indicated on details.
- F. Fittings:
 - 1. Refer to Round and Oval Ducts and Fittings General Requirements and Rectangular Ducts and Fittings General Requirements in this specification. Transverse and longitudinal seams shall be butt welded joints.
 - 2. Refer to drawings for additional information.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Construction Standards. Use construction methods which follow the requirements outlined SMACNA publications, as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.
- B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.
- C. Plenum Construction. Construct plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.

- D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.
- E. Wall and Floor Penetrations.
 - 1. Install fire, smoke and combination fire smoke dampers in floor penetrations and in one and two-hour rated walls where indicated in drawings and in accordance with Specification 23 33 00.
 - 2. Where ducts pass through walls in exposed areas, install suitable escutcheons made of galvanized sheet metal angles as closers.
 - 3. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required.
 - 4. Sleeves are required inside as well as outside chases.
 - 5. Provide 24 gage sheet metal sleeves for insulated ducts penetrating gyp board and CMU walls. Seal openings between ducts and sleeves with fireproofing sealants.
- F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the Section on painting. Do not install grilles, registers, or similar items until painting is complete.
- G. Ductwork Openings. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Ductwork Location. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities, including access to electrical and control panels.
- I. Instrument Test Hole Fitting. Provide instrument test ports as required in 23 33 00. Provide fittings to air balance contractor.
- J. Provide transitions at equipment and air device connections as per SMACNA standards. Where equipment requires an oval inlet and a round flex duct is routed to the equipment, provide insulated round to oval transition.
- K. Install duct mounted electric and hot water coils, provided in other specification sections, if required.
- L. Refer to mechanical details for information on terminal box connections, diffuser connections, fume hood connections, lab-trac equipment, etc.

3.02 SEAM AND JOINT SEALING

- A. All duct systems (except welded exhaust ductwork and double wall flue) shall be sealed. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A of SMACNA Standards irrespective of the duct pressure classifications

3.03 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports." Unless indicated otherwise in specifications.
- B. 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. Do not use wire to support ductwork.

- C. Horizontal Ducts Up to 40 Inches (Rectangular) Support horizontal ducts up to and including 40 inches in their greater dimension by means of band iron hangers sized per SMANCA attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Use clamps to fasten hangers to reinforcing on sealed ducts.
- D. Horizontal Ducts Larger Than 40 Inches (Rectangular). Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron (or equivalent unistrut) trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

The trapeze is to be placed on the exterior of non-compressible insulation between hanger and ductwork.

- E. Horizontal Round Ductwork. Support horizontal ductwork up to 36 inches with band iron hanger strap in accordance with SMACNA. For ductwork over 36 inches in diameter, support ductwork with iron band and unistrut supports as indicated in the details.
- F. Vertical Ducts. Support ducts to ensure rigid installation. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Fig. 5-8, Fig 5-10 "Riser Supports – From Floor". Support vertical ducts where they pass through the floor lines with 1-1/2 inches x 1-1/2 inches x 1/4 inch angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements. Support vertical duct drops more than 6 feet in length with angle iron frames attached to ducts.
- G. Refer to drawings for additional hanger details and requirements. Note that not all hangers are shown on the drawings are in the BIM model. The Contractor shall coordinate all hangers with the structure and other trades.
- H. For ductwork insulated with fire rated insulation, coordinate hanger support requirements with manufacturer's installation requirements.

3.04 FLEXIBLE DUCTWORK

- A. Low Pressure Flexible Ductwork
 - 1. Do not exceed 6 feet in length with any flexible duct.
 - 2. Flexible duct shall be limited to a maximum of a single 90 degree change in direction between the duct and the neck of the air device. This does not include the final turn into the neck of the air device.
 - 3. Support ductwork independently of lights, ceiling and piping. Provide harness at connection to ceiling diffuser as indicated on details.
 - 4. Provide two nylon panduits or stainless steel work clamps on inner core and seal connection with duct sealant. The insulation and outer jacket shall be slipped over inner core connection to point where insulation abuts insulation on duct or diffuser. The insulation connections shall be sealed by embedding scrim tape and sealant to form a vapor barrier.

3.05 LABORATORY EXHAUST DUCTWORK

- A. Butt-weld all joints and fittings using Gas Tungsten Arc Welding ("TIG") as indicated in Part 2. Welding procedures shall meet the requirements of SMACNA's The Managers' Guide for Welding. The welder shall be experienced and qualified with TIG welding. Prior to welding joints are fittings, the ductwork shall be free of rust, oil, paint or other foreign materials.

- B. Install ducts with an upward grade in the direction of flow. Make the grade a minimum of 1/8 inch per foot. Low places in the duct that can collect moisture will not be allowed. Use eccentric reducers, with the flat on bottom, in ductwork to maintain slope.
- C. All welds shall be cleaned with uncontaminated stainless steel wire brush prior to inspection. Welds shall be visually inspected and meet the requirements of AWS D9.1 and SMACNA's The Managers' Guide for Welding.

3.06 AUTOCLAVE EXHAUST DUCTWORK

- A. Provide ductwork as specified in Part 2. Install ductwork without forming dips or traps and slope a minimum of 1/2-inch per foot towards ceiling grilles or canopy hood. Construction shall be watertight.
- B. Terminate ductwork at exhaust fan as recommended by fan manufacturer.

3.07 FLASHING

- A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gage stainless steel or 16 ounce copper.

3.08 TESTS

- A. Allowable Leakage. Test ductwork for leaks in accordance with SMACNA testing procedures before concealing or insulating as indicated below. Arrange for the Owner's Representative to witness the test.
 - 1. Low pressure ductwork. Test low pressure ductwork at +2 inches W.G. Maximum allowable leakage (L_{max}) per 100 ft² of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 6$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and $P = 2$ " for low pressure ducts. Maximum allowable leakage shall also be less than 3% of total system air flow rate.
 - 2. Medium pressure ductwork. Test medium pressure ductwork at +6 inches W.G. Maximum allowable leakage (L_{max}) per 100 ft² of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 4$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and $P = 6$ " for medium pressure ducts. Maximum allowable leakage shall also be less than 3% of total system air flow rate.
 - 3. Lab exhaust ductwork. Test laboratory exhaust ductwork at +6 inches w.g. Maximum allowable leakage is 3% of the total system air flow rate. Where partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - 4. Test the following ductwork:
 - a. Low pressure ductwork:
 - 1) All ductwork served by terminal boxes.
 - 2) All ductwork served by fan coil units.
 - b. Medium pressure ductwork:
 - 1) All ductwork served by individual air handling units.
 - 2) All ductwork served by exhaust fans.
 - c. Other
 - 1) Do not test Double Wall Flue Piping or Dryer Exhaust Ductwork.
- B. Equipment. Provide equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.

3.09 CLEANING

- A. Protect all ductwork and equipment from dirt during storage, installation and prior to grille, diffuser installation with protective covering at each end. Ductwork exposed to dirt and dust due to inadequate protection will have to be removed, cleaned and reinstalled.
- B. Do not operate any air handling units or fan coil units during construction without filters.

- C. Provide temporary filters on return air ductwork during construction to protect ductwork from dust.
- D. Provide temporary filters on exhaust grilles during construction to protect ductwork from dust.
- E. Do not operate laboratory exhaust fans during any drywall operation to protect ductwork, hoods and laboratory control products.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fire dampers.
 - 2. Combination fire and smoke dampers.
 - 3. Smoke dampers.
 - 4. Volume control dampers.
 - 5. Duct access doors.
 - 6. Conical spin-in fittings and taps
 - 7. Duct accessory hardware.
 - 8. Flexible Connection
 - 9. Roof Duct Supports
 - 10. Laboratory exhaust accessories

1.02 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specification 23 31 13, Ductwork

1.03 SUBMITTALS

- A. Product Data: Submit product data for each product. Refer to Section 23 00 10.
- B. Fire and Combination Fire/Smoke Damper. Include manufacturer's literature to include performance data and installation requirements. Include any wiring diagrams. Installation shall clearly indicate
 - 1. Proposed break-away connections used on the project.
 - 2. Clearance requirements between wall/floor and damper.
 - 3. Mounting/Retaining locations, size, gauge and fastener requirements.
- C. Access Doors. Include type of material, installation guidelines, leakage rates and maximum pressure data.
- D. Volume Control Dampers. Include type of material, installation guidelines, pressure drop and maximum pressure data.
- E. 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 and smoke-damper installations, including sleeves; and duct-mounted access doors. Provide break-away duct/sleeve connection detail.
 - e. Wiring Diagrams: For power, signal, and control wiring.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Fire dampers, smoke dampers and combination fire/smoke dampers.
 - 1. Include operation and maintenance information, including recommended testing requirements.

2. Assign identification numbers (FD – Fire Damper, FSD – Fire/smoke Damper, SD – Smoke Damper) for each damper. Include table in O&M manual that indicates identification number, room location, duct system and size.

1.05 QUALITY ASSURANCE

- A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references
 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
 2. AMCA 500-D, "Laboratory Method of Testing Dampers for Rating"
 3. NFPA 101 - Life Safety Code.
 4. SMACNA - HVAC Duct Construction Standards Metal and Flexible – Second Edition
 5. UL 555 – Standard for Fire Dampers.
 6. UL 555C – Standard for Ceiling Radiation Dampers.
 7. UL 555S – Standard for Smoke Dampers

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fire, Smoke and Fire/Smoke Dampers. Greenheck, Pottorff, Ruskin.
- B. Flexible Connections. Ductmate, Ventfabrics Ventglass.
- C. Duct Access Doors. Ductmate, Flexmaster, Greenheck, Ruskin, United McGill.
- D. Roof Duct Supports. Portable Pipe Hangers, MAPA Products.
- E. Conical Spin-in Fittings. Flexmaster, Buckley
- F. Volume Control Dampers. Flexmaster, Greenheck, Prefco, Ruskin.

2.02 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.
- 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/A 480M, Type 304 or 316L, and having a No. 2 finish for concealed ducts and 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.

2.03 FIRE DAMPERS (FD)

- A. Quality Standards. Furnish and construct fire dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F fusible link.
- B. Construct fire dampers such that damper frame material and curtain material are galvanized.
- C. Use Curtain Type Fire Dampers for fire dampers where possible. Use Multiple Blade Fire Dampers for fire damper sizes that exceed manufacturer's allowable Curtain Type Fire Damper sizes, or where velocities or pressures exceed Curtain Type Fire Dampers.
- D. Curtain Type Fire Dampers (Type B)
 1. Damper shall be classified for dynamic closure to 2000 fpm and 4 inches w.g. static pressure.
 2. Damper shall have frame constructed from galvanized steel.

3. Blades shall be galvanized steel.
 4. Closure springs shall be Type 301 stainless steel, constant force or spring clip type.
 5. Provide Grille, Grille Access Type or Out of Wall Type of frame where indicated on drawings.
- E. Multiple Blade Fire Damper
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 90"x64" for vertical installation and 60"x48" for horizontal installation.
 2. Damper shall have frame constructed from galvanized steel channel and reinforced at the corners.
 3. Blades shall be 6" wide airfoil type and constructed from galvanized steel.
 4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
 5. Blade seals shall be galvanized steel for flame seal to 1,900 degrees F and mechanically attached to blade edge.
 6. Linkage shall be concealed in frame.
 7. Provide plated steel hex shaped axle attached to blade.
 8. Pressure drop shall be a maximum of 0.07 inches w.g. at 1,500 feet per minute through 24 x 24 inch damper.

2.04 COMBINATION FIRE AND SMOKE DAMPERS (FSD)

- A. Quality Standards. Furnish and construct combination fire/smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120"x96" for vertical installation and 144"x96" for horizontal installation.
 2. Damper shall have frame constructed from galvanized steel channel and reinforced at the corners.
 3. Blades shall be 6" wide airfoil type and constructed from galvanized steel.
 4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
 5. Blade seals shall be silicone material mechanically attached to blade edge. Provide stainless steel flexible metal compression jamb.
 6. Linkage shall be concealed in frame.
 7. Provide plated steel hex shaped axle attached to blade.
 8. Temperature Release Device. Close in a controlled manner and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
 9. Actuator. Provide electric 120V, 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
 10. Pressure drop shall be a maximum of 0.12 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.
 11. Provide open/closed feedback status signals on each damper for remote testing and monitoring.

2.05 SMOKE DAMPERS (SD)

- A. Quality Standards. Furnish and construct smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120"x96" for vertical installation and 144"x96" for horizontal installation.
 2. Damper shall have frame constructed from galvanized steel channel and reinforced at the corners.
 3. Blades shall be 6" wide airfoil type and constructed from galvanized steel.
 4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
 5. Blade seals shall be silicone material mechanically attached to the blade edge. Provide stainless steel flexible metal compression jamb.
 6. Linkage shall be concealed in frame.
 7. Provide plated steel hex shaped axle attached to blade.
 8. Actuator. Provide electric 120V, 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
 9. Pressure drop shall be a maximum of 0.12 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.
 10. Provide open/closed feedback status signals on each damper for remote testing and monitoring.

2.06 VOLUME CONTROL DAMPERS

- A. Provide volume dampers in round and rectangular ductwork where indicated on drawings. These dampers are for manual balancing of systems only and are not for actuated control dampers.
- B. General Fabrication Requirements:
1. Comply with SMACNA Chapter 2, "Volume Dampers" unless more stringent requirements are indicated. Provide single blade dampers on round dampers and for rectangular dampers not exceeding 36-inches in width or 12-inches in height. Provide multiblade rectangular dampers for dampers exceeding 36-inches in width or 12-inches in height or where required due to velocity or pressure requirements.
 2. Refer to Specification 23 31 13 Ductwork for application table that defines Low and Medium Pressure ductwork.
 3. Provide a locking hand quadrant on all dampers. Mount quadrant regulators on stand-off mounting brackets, bases, or adapters on insulated ducts. Quadrant handle shall have infinite adjustable positions between open and closed.
 4. For stainless steel ductwork, provide stainless steel finish to match ductwork material.
 5. Shop fabricated dampers are not acceptable.
- C. Round Dampers.
1. Low Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade, continuous 3/8" square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 2"W.G. when closed, and a maximum pressure drop of 0.03"W.G at 1500 feet per minute through a 20-inch damper when tested in accordance with AMCA Fig. 5.3.
 2. Medium Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 14 gage (equivalent) galvanized steel blade, continuous 1/2" square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 4"W.G. when closed, and a maximum pressure drop of 0.06"W.G at 2000 feet per minute through a 24-inch damper when tested in accordance with AMCA Fig. 5.3.

D. Rectangular Dampers.

1. Low Pressure Single Blade Damper (Fans systems with less than 1"W.G. Static Pressure). Provide single blade damper with minimum 3-inch x 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade on dampers up to 18-inches wide, 16 gage on dampers over 18-inches wide. Provide a continuous 3/8" square plated steel axle mechanically attached to blade, and synthetic flanged sleeve type bearing. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 1"W.G. when closed.
2. Low Pressure Multi-Blade Damper. Provide opposed multi-blade damper with minimum 5-inch x 16 gage galvanized steel frame, minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 3"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.1"W.G. at 1500 feet per minute through a 24-inch x 24-inch damper.
3. Medium Pressure Damper. Provide opposed multi-blade damper with minimum 5-inch x 16 gage galvanized steel channel frame. Blades shall be minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 5"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.16"W.G. at 2000 feet per minute through a 24-inch x 24-inch damper when tested in accordance with AMCA Fig. 5.3.

2.07 DUCT ACCESS DOORS

A. Square Frame Access Doors

1. Low Pressure Ductwork
 - a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 2 manually operated cam locks on access doors 16-inches and under, 4 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
 - b. Performance. 24"x24" access door shall be suitable for up to 2"W.G. and have a maximum leakage of 4.5 CFM/sq.ft. at 1"W.G. pressure.
2. Medium Pressure Ductwork
 - a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 4 manually operated cam locks on access doors 16-inches and under, 8 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
 - b. Performance. 24"x24" access door shall be suitable for up to 10"W.G.

B. Round "Spin" Access Doors

1. Construct outer frame of minimum 22 gage roll formed, double hemmed galvanized steel. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 3 manually operated cam locks on access door. Provide continuous foam gasket between door and frame.

C. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

D. Where duct size permits, access door size shall be 24-inches in diameter or 24" x 24" for oval and rectangular doors. For duct sizes under 26-inches, provide access door 2-inches smaller than duct size. For ducts 12-inches wide, provide minimum 10" x 12".

2.08 CONICAL SPIN-IN FITTINGS AND TAPS

- A. General Construction. For stainless steel ductwork, provide stainless steel finish to match ductwork material.
- B. Furnish conical spin-in fittings with quadrant dampers at all round runout ducts serving diffusers and grilles. Fabricate conical fitting of 26-gage galvanized sheet metal with 2-inch build out, continuous 3/8" square shaft, air tight nylon bushings and locking quadrant handle. Connect damper plate to shaft with a minimum 2 u-bolts on dampers 12-inches and greater. Quadrant handle and damper shall have infinite adjustable positions between open and closed.

2.09 INSTRUMENT TEST HOLES

- A. Permanent Instrument Test Holes: Factor fabricated of cast iron, cast zinc alloy or cast aluminum to suit duct material, airtight flanged fittings including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness. Similar to DuroDyne TH/IP or Ventfabrics 699. Provide permanent instrument test holes at the following locations:
 - 1. In supply air ductwork at air handling unit connections.
 - 2. Upstream and below the roof for roof mounted fans.
 - 3. Upstream or downstream of duct mounted coils, not including terminal boxes or fan coil units.
- B. Temporary Instrument Test Holes: Drill temporary test holes for balancing in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Provide neat patch on external duct insulation and label as "Test Plug".

2.10 FLEXIBLE CONNECTIONS

- A. Provide air-tight flexible connections where ductwork connects to fans, package rooftop DX units, and fan coil units with fabric as specified below:

Application	Fabric	Coating	Gauge
HVAC (Indoor)	Fiberglass	Neoprene	28
HVAC (Outdoor & Lab)	Fiberglass	Hypalon	28

- B. The fabric shall be UL listed, fire retardant, waterproof and mildew resistant, crimped into metal edging strip.

2.11 ROOF DUCT SUPPORTS:

- A. Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane. Factory fabricated to support exact duct sizes to be installed.
- B. Design system using minimum 14 inch x 16 inch high density polyethylene or 14 gauge stainless steel bases.
- C. Provide 1-5/8 inch or 1-7/8 inch 12 gage stainless steel structural steel framing, as required for loading conditions. Framing shall be 3-sided or tubular shape with mill finish.
- D. Provide stainless steel clamps, bolts, nuts, washers, and other devices as required for a complete system.

2.12 LABORATORY EXHAUST ACCESSORIES

- A. C.A.T.S. E-Z Joint Connector. Provide Type 316L stainless steel round duct joint connector for connection of ductwork at lab exhaust valve as indicated in drawing details. Product shall be manufactured by Standard Sheet Metal Works. System shall consist of 1/2" flanged end duct connectors meeting requirements of SMACNA, and suitable up to 30"W.G. positive/negative pressure. System shall include Nitril/PVC blend gasketing.
- B. Fernco Fitting. Provide Fernco coupling at fume hood connection as indicated in drawing details. Coupling shall resistant to UV and conform to ASTM D5926. Provide two stainless steel clamps for connection to ductwork. Coupling shall be suitable for temperatures between -30°F and 140°F and pressures up 4.3 psig.

C. Canopy Hood

1. Provide Type II single baffle exhaust canopy hood. The hood shall be constructed of a minimum of 18-gauge 400 series stainless steel. The hood shall be constructed using the standing seam method for optimum strength. All seams, joints, and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable.
2. The hood shall include one full length, removable condensate baffle constructed of 18-gauge stainless steel. The baffle shall be pitched to drain into a full perimeter welded, condensate collecting gutter with a ½ inch stainless steel drain fitting.

PART 3 EXECUTION

3.01 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 ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. 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.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.02 ACCESS DOORS

- A. Install duct access doors on sides or bottom of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. Upstream and downstream of duct mounted duct coils.
 2. Downstream of control dampers.
 3. Upstream of airflow measuring stations.
 4. Adjacent to and close enough to fire, smoke and combination fire/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. Where size of the ductwork permits, provide minimum 18"x16" size access door. If access door will be less than 12"x12", provide a 24" long removable section of duct downstream of damper for access.
 5. At duct mounted smoke detectors.
 6. Upstream or Downstream of turning vanes.
 7. Elsewhere as indicated on drawings, details or specifications.
- B. Label access doors according to Section 23 05 53 - Identification for HVAC Piping and Equipment to indicate the purpose of access door.

3.03 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

- A. Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.
- B. Install dampers square and free from racking with blades running horizontally.
- C. Do not compress or stretch damper frame into duct or opening.

- D. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.
- E. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
- F. Provide access doors for all fire, smoke and combination fire/smoke dampers. Refer to details for additional requirements.

3.04 CONICAL SPIN-IN FITTINGS AND TAPS

- A. Install conical spin-in fittings with quadrant dampers to serve diffusers as indicated on drawings.
- B. After installation of spin-in fitting, seal all around connection to meet leakage class indicated in Specification 23 31 13.

3.05 VOLUME CONTROL DAMPER

- A. 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.
- B. Set dampers to fully open position before testing, adjusting, and balancing.

3.06 ROOF DUCT SUPPORTS

- A. Verify that roofing system is complete and that roof surfaces are smooth, flat, and ready to receive work of this Section. Verify that roof surface temperature is at minimum 60°F for proper adhesive performance.
- B. Clean surfaces of roof in areas to receive portable support bases. Remove gravel from gravel surfaced roofs. Remove dirt, dust, oils, and other foreign materials. Prime roofing membrane with a primer compatible with existing components in the roofing system.
- C. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all ducts, whether or not all required devices are shown. Install framing at spacing indicated, but in no case at greater than 15 ft on center. Accurately locate and align bases. Set in adhesive if required by manufacturer's installation instructions. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated. Use stainless steel fasteners for stainless steel framing. Install ductwork as shown on detail.

3.07 FLEXIBLE CONNECTIONS

- A. Install at connections between ductwork and motor driven equipment as shown. Provide a minimum of 1 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts and equipment. Also provide a minimum of 1 inch slack for each inch of static pressure on the fan system. Securely fasten flexible connections to equipment and to adjacent ductwork by means of sealant with sheet metal screws. Where flex ductwork is connected to oval collars in diffusers and plenums, provide a metal transition fitting from oval to round.

3.08 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate all volume 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, smoke and combination fire/smoke dampers to verify full range of movement per NFPA and verify that proper heat-response device is installed.

END OF SECTION

SECTION 23 3413 FANS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes requirements for furnishing and installing fans and supplemental equipment including the following:
 - 1. Centrifugal fans.
 - 2. High Dilution Laboratory Exhaust Fans.

1.02 PERFORMANCE

- A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as shown. Fan capacities and characteristics are scheduled on the drawings.
- B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA standards. All fans provided must be licensed to bear the Certified Ratings Seal.
- C. Statically and dynamically balance all fans.
- D. High Dilution Fan System:
 - 1. Each fan shall be vibration tested before shipping. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes - horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.10 in./sec peak velocity, filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the Engineer and Owner upon shipment of fan.
- E. Fan Efficiency
 - 1. For fans greater than 5 HP, the fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers' certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

1.03 SUBMITTALS

- A. General:
 - 1. Submit shop drawings and product data.
 - 2. Shop drawings shall indicate assembly, unit dimensions, weight, required clearances, construction details and field connection details.
 - 3. Product data shall indicate capacities, ratings, fan performance, motor electrical characteristics, and gages and finishes of materials.
 - 4. Provide fan curves with specified operating point clearly plotted.
 - 5. Provide the fan's fan efficiency grade (FEG), peak total efficiency and operating efficiency as defined by AMCA 205.
 - 6. Include backdraft damper information for each fan, including the size of the backdraft damper.
 - 7. Submit sound power levels.
 - 8. Submittals shall show compliance with Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - 9. Support & restraint details shall be designed for the wind loading applicable to the site and shall be sealed by a professional engineer registered in Texas.
 - 10. Provide static pressure losses for all equipment provided by the fan manufacturer.

- B. High Dilution Lab Exhaust Fans - Provide nozzle velocity of exhaust fan, total exhaust flow at inlet and outlet, discharge plume rise at specified wind velocity, wiring diagram and drawing of roof curb, plenum, dampers, and fan assembly. Each fan shall be vibration tested before shipping. Each assembled fan shall be test run at the factory at the specified fan RPM, and vibration signatures shall be taken on each bearing in three planes - horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.10 in./sec peak velocity, filter-in reading as measured at the fan RPM. Provide copy of report upon shipping.

1.04 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Include installation instructions, assembly views, lubrication instructions and replacement parts list.
- C. Include copy of approved submittals (with all comments corrected).
- D. Include copy of vibration test reports.
- E. Include copy of airflow measuring station calibration curves.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.
- C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.
- D. Check and maintain equipment on monthly basis to ensure it is being stored in accordance with manufacturer's recommended practices. Additionally, during each check, fans and motors shall be rotated and greased and shaft shall be left approximately 180 degrees from that of previous month. Storage records shall be maintained that indicate above requirements have been met.

1.07 WARRANTY

- A. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
- B. The warranty of this equipment is to be free from defects in material and workmanship for a period of 12 months from substantial completion. Any units or parts which prove defective during the warranty period will be replaced at the manufacturers' option when returned to the manufacturer, transportation prepaid.
- C. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished prove defective during this period, they should be returned to the nearest authorized motor service station.

1.08 AIR FLOW MEASURING STATION

- A. Fans with Air Flow Monitoring selected shall include the following.

1. Flow monitoring station shall monitor the pressure difference between the fan inlet and the smallest diameter of the inlet cone.
2. Volumetric flow to be calculated from empirically derived formulas based on testing by the fan manufacturer.
3. Flow monitoring station shall not use air restricting probes that reduce fan performance or create additional fan sound.
4. Four equidistantly spaced sensor orifices to be drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor to extend to a termination plate mounted on the fan housing.
5. High-pressure flow probe(s) to be mounted in low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing.
6. Termination plate shall include a low-pressure connection, a high-pressure connection, and a listing of the empirically determined flow rate coefficient.
7. Flow monitoring station shall accurately measure the pressure differential to within $\pm 3\%$.
8. Flow monitoring station to be installed by the fan manufacturer as part of the standard fan assembly.

PART 2 PRODUCTS

2.01 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. High Dilution Lab Exhaust Fans:
 - a. Strobic Model Tri-Stack.
 - b. Owner approved alternate.

2.02 PROTECTIVE COATINGS

- A. Manufacturer's Standard: Apply manufacturer's standard prime coat and finish to fans, motors and accessories, except on aluminum surfaces or where special coatings are required.
- B. Galvanizing:
1. After fabrication of the parts, hot-dip coat all surfaces which require galvanizing.
 2. Where galvanizing is specified, a zinc coating may be used.
 3. After fabrication, apply the zinc coating and air-dry the coating to 95 percent pure zinc.
 4. Acceptable zinc coatings include Zincilate, Sealube, Amercoat, Diametcoat, or an approved equal.
- C. Laboratory Exhaust Fans.
1. All steel and aluminum surface components within the airstream that are not stainless steel or fiberglass must be surface prepped by abrasive blast clean to SSPC-SP10. Chemically cleaning of these components as a form of surface preparation is not acceptable. These components must be coated with a high solids epoxy with low VOC chemical resistant barrier coating epoxy. The coating system, a total thickness of up to 11 mils, shall not be affected by the UV component of sunlight, and shall have superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 7000 hour ASTM B117 Salt Spray Resistance. Standard finish color to be gray.
- D. Fasteners for all fans and relief hoods mounted outside of building shall be stainless steel.

2.03 SUPPLEMENTAL EQUIPMENT

- A. Motor Covers: Provide weatherproof motor covers for installations out of doors. Apply the same finish as used on the fan.
- B. Belt Drives:
1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20 percent speed variation from full open to full closed. Size drives for 150 percent of rated horsepower. Key the fan sheave to the fan shaft.

2. Nonadjustable motor sheaves may be used for motor sizes over 15 horsepower, at the Contractor's option. However, if changing a nonadjustable sheave becomes necessary to produce the specified capacity, the change must be made at no additional cost.
 3. Provide belt guards and apply the same finish as used for the fan.
- C. Safety Disconnect Switch: Provide a factory-wired, safety disconnect switch on each unit equipped with a 115/1/60 motor. Division 26 will provide safety disconnect switches for all motors that are not 115/1/60, such as three phase motors, unless noted otherwise in specifications or fan schedule.
- D. Prefabricated Roof Curbs: Furnish prefabricated roof curbs with built-in cant strips and lined with glass fiber insulation. Curbs may be made of No. 18 U.S. standard gage galvanized steel or 0.063 inch aluminum. The minimum height is 8 inches. Include on each roof curb a resilient pad for equipment mounting on the top flange. Include damper tray where indicated on schedule or specifications. Refer to High Plume Dilution Fans for additional requirements for additional requirements for High Plume Dilution Fans.
- E. Motors. All 115/1/60 motors shall be provided with thermal overload protection.
- F. Nameplates. Provide an aluminum or stainless steel nameplate secured with screws to the equipment in a location that is readable when the equipment is installed and in operation. The following information shall be included on the nameplate: manufacturer, model number, serial number, date of manufacture, Motor HP, Motor enclosure, motor volts/ph/hz and rpm, design CFM, design SP, Fan Class, Fan RPM, Max RPM.

2.04 HIGH DILUTION LAB EXHAUST FANS

- A. General:
1. Base fan performance at standard conditions (density 0.075 Lb/ft³), 75°F airstream.
 2. Fans selected shall be capable of accommodating static pressure and flow variations of $\pm 15\%$ of scheduled values.
 3. Each fan shall be direct driven in AMCA arrangement 4 according to drawings.
 4. Fans to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
 5. Fan, plenum, and dampers shall be coated as indicated under "Protective Coatings" in Part 2 of this specification. applied and baked.
 6. All fasteners shall be stainless steel.
 7. Curb cap shall be 316 stainless steel for corrosion resistance.
 8. Fan assemblies that use flexible connectors that can fail and cause loss of laboratory containment shall not be acceptable.
 9. Fan assembly shall be designed for a minimum of 125-mph wind loading, without the use of guy wires.
 10. Motor cover shall be split design and hinged for ease of maintenance on units with a housing diameter of 60 inches and larger.
- B. Fan Housing and Outlet:
1. Fan housing shall be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
 2. Fan housing shall be bifurcated, allowing all drive components, including the motor, to be serviced without contact of the contaminated air stream. Must be manufactured of welded steel coated as indicated under "Protective Coatings" in Part 2 of this specification. No uncoated metal fan parts will be acceptable.
 3. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.

4. A multi-stage air induction discharge nozzle shall be supplied by the fan manufacturer, be integral to the fan body, and be designed to efficiently handle an outlet velocity of up to 7000 FPM. The multi-stage nozzle shall induce ambient air up to 270% of fan capacity. Nozzle/Wind band assemblies that are manufactured by third party vendors or having mechanical properties less than steel shall not be acceptable.
 5. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.
 6. An access door shall be supplied for impeller inspection and service.
 7. Fan assembly shall be AMCA Type C spark resistant construction minimum.
- C. Fan Impeller:
1. Fan impeller shall be mixed flow design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.
 2. Fan impeller shall be manufactured of welded steel and coated as indicated under "Protective Coatings" in Part 2 of this specification..
 3. Fan impellers that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel and lower maximum tip speeds are not acceptable.
- D. Bypass Air Plenum:
1. A bypass-air plenum shall be provided as indicated on schedule. The plenum shall be provided with bypass-air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass-air rain hood and bird screen.
 2. The plenum shall be constructed of welded cold rolled steel, and coated as indicated under "Protective Coatings" in Part 2 of this specification. Plenums that are fabricated of plastics or resin that are combustible and have mechanical properties less than steel shall not be acceptable.
 3. The plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule.
 4. Vortex breakers shall be provided on all side inlet and multiple fan plenums.
 5. The bypass-air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer.
 6. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be permitted.
 7. Bypass-air dampers (where scheduled) shall be airfoil type, opposed-blade design, Type 304 stainless steel construction and coated as indicated under "Protective Coatings" in Part 2 of this specification. Bypass dampers shall have stainless steel damper rods, bearings and jamb seals and the blades shall have polymer edge seals. Dampers shall be suitable for application up to 10 inches w.g. Damper blade drive linkage shall be set by manufacture and welded to eliminate linkage slippage. Bypass dampers shall be sized to bypass the airflow capacity of one fan at the required static pressure of the system.
 - a. Dampers shall be controlled by a 24v electric proportional control damper actuator. Actuator shall be electronic direct-coupled type, which require no crankarm and linkage. Actuators must provide proportional damper control in response to a 2-10 VDC or 4-20 mA control input from the DDC. A 2-10 VDC feedback signal shall be provided for position indication.
 8. Fan isolation dampers shall be parallel-blade design, airfoil design, fabricated of Type 304 stainless steel and coated as indicated under "Protective Coatings" in Part 2 of this specification. Isolation dampers shall have stainless steel damper rods, bearings and jamb seals and the blades shall have polymer edge seals. Dampers shall be suitable for application up to 10 inches w.g. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage.
 - a. Damper actuators shall be 2-position, spring return, direct coupled type, which require no crankarm and linkage, capable of direct mounting to a jackshaft. Actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation.

9. Actuators for the bypass dampers and fan isolation dampers shall be provided by Division 23 and be located in an NEMA 4 enclosure.
 10. Provide EPDM closed cell foam tap between curb and roof curb.
- E. Bypass Air Plenum Curb:
1. Exhaust system manufacturer shall supply a structural support curb for the plenum of specified height as shown on the drawings.
 2. Curb shall be fabricated of a minimum of 12 gauge corrosion-resistant coated steel and structurally reinforced. Curb shall be coated as indicated under "Protective Coatings" in Part 2 of this specification.
 3. Curbs shall be insulated with a minimum of one inch of fiberglass insulation.
 4. When properly anchored to the roof structure, the standard curb/ plenum/blower assembly shall withstand wind loads of up to 125 mph without additional structural support.
- F. Fan Motors and Drive:
1. Motors shall be premium efficiency, standard NEMA frame, 1800 RPM, TEFC with a 1.15 service factor. Refer to Specification 23 05 13 for additional motor requirements. Division 26 will provide and install a NEMA 4X disconnect switch.
 2. Drive arrangement shall be AMCA arrangement 4, utilizing a tapered bushing connecting the motor shaft to impeller.
 3. All non-permanently lubricated motors shall have stainless steel braided extended lube lines with zerk fittings.
 4. Motors shall be isolated from the exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fans level and plumb.
- B. Install units with clearances for service and maintenance.
- C. Label fans according to requirements specified in Section 23 05 53, Identification for HVAC Piping and Equipment.

3.02 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 Section 23 33 00, Air Duct Accessories.
- B. Ground equipment according to Division 26 requirements.
- C. Connect wiring according to Section 26 05 19, Insulated Conductors.

3.03 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 confirm proper motor rotation and unit operation, 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.

3.04 HIGH DILUTION LAB EXHAUST FANS

- A. Flange ductwork over roof curb and install gasket as recommended by manufacturer.
- B. Bolt fan to curb and bolt or weld curb to roof deck as detailed on architectural details.
- C. Assemble plenum, bypass dampers, isolation dampers and fan as recommended by manufacturer.
- D. Ductwork connection to fan plenum shall be a maximum of 1500 fpm or less if required by manufacturer.
- E. Connect all control wiring between dampers, actuators and power wiring. Provide necessary relays and contacts for proper operation.
- F. Manufacturer's representative shall inspect installation prior to start-up of fan. Representative shall provide letter report to engineer after inspection. A copy shall be included in the O&M Manual.

END OF SECTION

**SECTION 23 3600
AIR TERMINAL UNITS**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes air distribution devices including the following:
 - 1. Single Duct Terminal Units.

1.02 COOPERATION WITH OTHER TRADES

- A. Coordinate work with Division 26 Electrical Sections to ensure intended functions of lighting and air systems are achieved.

1.03 SUBMITTALS

- A. Product Data: Submit schedule for each box indicating size, capacity, sound data and other data to show compliance with the specifications and schedule on drawings. Submit product data indicating materials, finishes and options provided that clearly indicate compliance with Part 2 of this Section. For all types of terminal boxes, provide documents proving that the box performance as submitted has been certified by an independent laboratory.
- B. Samples: At the request of the Owner and/or A/E team, submit one terminal unit of each specified for review.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
 - 1. Trane
 - 2. Price
 - 3. Titus

2.02 TERMINAL BOX CROSS-FLOW AVERAGING SENSOR (APPLIES TO ALL TYPES OF TERMINAL BOXES)

- A. Units shall be provided with a grid of multipoint velocity sensors. Each flow cross shall include a minimum of 8 pickup points of amplified sensing for each 16 inches of duct diameter. The pickup points shall be divided evenly in each of the four quadrants of the duct. Ducts larger than 16 inches in diameter shall be divided into sections which are each averaged to its respective center and then cascaded so that the entire cross-sectional area is traversed.
- B. Center tapped averaging sensors shall provide a differential pressure signal that represents actual airflow within an accuracy of +5 percent of maximum rated flow. This accuracy shall be maintained when inlet duct varies from straight to 90 degrees entrance approach angle.

2.03 SINGLE DUCT TERMINAL BOXES (TYPE CV AND VV)

- A. Furnish boxes with performance certified as per ARI Standard 880, for installation above the ceiling with capacities as scheduled. Boxes shall be listed in the latest ARI directory. Provide boxes supplied by the manufacturer fully assembled with air dampers, heating coil, self-contained volume regulator, and disconnect switch. Select boxes with maximum scheduled CFM within mid to 80 percent of box listed capacity range. All controls components including HVAC controller shall be supplied by the ATC Contractor for field installation. Controls shall be electronic for DDC application.
- B. The damper actuator will be field installed. All required linkages must be furnished and factory-installed and performance tested by the box manufacturer. Provide control transformer, disconnect switch, etc., as required.
- C. Box maximum volumes shall be adjustable through DDC over the entire range of operation. Contractor shall verify all maximum and minimum volumes in the field.

- D. Air valve shall be pressure independent and designed for tight shutoff with maximum leakage of 2% of unit maximum rated airflow at 3.0 inches s.p. Valve shall maintain desired flow within 5 percent when inlet pressure varies between 1/2 and 3 inches water gage. The damper actuator and all the necessary linkages shall be installed and performance tested by box manufacturer. Box maximum and minimum volumes shall be adjustable through DDC over the entire range of operations.
- E. Set the damper linkages so that primary air delivered to the box varies from 100 percent to scheduled minimum, depending upon the cooling load.
- F. Casing shall be single wall 20-gage galvanized steel, internally lined with at least 1 inch thick, 1-1/2 lb dual density insulation of fiberglass complying with UL 723 and ASTM E84 (flame/smoke requirements) and UL 181 (mold growth & humidity). All exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the air stream.
- G. Casing leakage shall not to exceed the following at 1 inch water gage. Tapes and sealants on the exterior of the casing are not acceptable except at connection of hot water coil to terminal box. Except for boxes with electric reheat, provide gasketed access door with 1/4 turn metal cam lock in bottom of terminal box.

Box Inlet Size (in)	Casing Leakage CFM
4 - 14	10
16	14

- H. Limit installed unit discharge sound levels to NC-30 and radiated to NC-30, based upon 1"W.G. static pressure drop across the unit. NC shall be reported calculated using the acoustical reductions indicated in latest version of AHRI 885, appendix E.
- I. Electric Heating Coil (where scheduled). Provided the capacity scheduled on the drawings. The heating coils shall be factory mounted at the discharge outlet of the terminal unit. The entire assembly shall be constructed of heavy gauge galvanized steel. Heaters shall be UL listed for zero clearance and meet all applicable requirements of the NEC. Resistance wire shall be 80 percent nickel and 20 percent chromium. Furnish heater with airflow switch, SCR power to heating elements or magnetic contactors, fan relay, control voltage transformer, high limit thermal cut-out, and a NEMA 1 electrical enclosure. No magnetic contactors are allowed. Provide a fused main power disconnect as an integral component of the unit (for both fan and heater).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Seal connection at box, as required, to comply with system maximum leakage. Install ductwork at inlet of boxes so that the maximum straight run of duct is achieved at the box inlet. Install boxes so that minimum 3'-0" clearance is maintained in front of box-mounted control and electrical panels. Refer to detail for additional requirements.
- B. Store units under protective tarps and in accordance with manufacturer's installation instructions.
- C. Provide clear access to unit mounted access doors on bottom of units.
- D. Field insulate all exposed heating coil ubends, headers and coil casing with specified duct insulation.
- E. Seal the connection between the coil and the terminal box with duct sealant.

END OF SECTION

SECTION 23 3713 AIR DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes air distribution devices including the following:
 - 1. Diffusers.
 - 2. Grilles.
 - 3. Registers.

1.02 COOPERATION WITH OTHER TRADES

- A. Coordinate work with Division 26 Electrical Sections to ensure intended functions of lighting and air systems are achieved.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: At the request of the Owner and/or A/E team, submit each exposed product for each color and texture specified.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
 - 1. Diffusers, Grilles and Registers. Greenheck/Metalaire, Krueger, Price, Titus, Tuttle&Bailey.

2.02 DIFFUSERS

- A. Square Plaque Diffuser (MARK A, P):
 - 1. Provide aluminum plaque diffuser, precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated that drops no more than 1/4 inch below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.
 - 2. Finish shall be White Powder Coat.
 - 3. Provide transitions for rectangular duct connections if required.
- B. Perforated Return/Exhaust (MARK C, CC, D, DD, R, RR, S, SS, TT):
 - 1. Provide steel frame construction with aluminum perforated face and white factory finish. Frame the diffuser face with a mitered and welded frame.
 - 2. Face shall have no less than 51% free area.
- C. Flush Faced Radial (Laboratory) Diffusers (MARK G, H):
 - 1. Air diffuser shall provide a flush face, non-aspirating radial air pattern, projecting air horizontally, vertically in a radial direction.
 - 2. Shall be constructed of 6 inch tall stainless steel back pan. All pattern controllers shall be internal to the unit. Provide foam gasketing.
 - 3. The face of the diffuser shall be constructed of perforated stainless steel, and shall not protrude below the ceiling. Provide white finish on face and frame.

2.03 GRILLES

- A. Supply (MARK ES):
 - 1. Use double-deflection supply grilles made of aluminum.

2. Install vertical face blades and horizontal rear blades. Provide solid, extruded aluminum blades which are individually adjustable. Space at not more than 3/4 inch centers for rear blades and 1/2 inch centers for face blades and not less than 5/8 inch deep.
 3. Employ grille frames of extruded aluminum with welded and mitered corners and mounting gaskets.
 4. Provide white finish on all grilles unless indicated otherwise on drawings.
 5. Provide integral aluminum opposed blade damper with mill finish.
- B. Return and Exhaust (MARK ER, EE):
1. For ceiling return, provide scheduled diffuser with white factory finish. Use construction and frame styles as specified for ceiling diffusers, but without pattern controllers. Use neck sizes as shown.
 2. For wall return and exhaust, provide a 45 degree fixed-blade aluminum grille. Provide 3/4 inch blade spacing as scheduled, with front blades parallel to long dimension. Provide solid, extruded frames and aluminum blades which are individually adjustable on sizes larger than 24 inches x 24 inches, roll-formed aluminum blades for smaller grilles. Include mounting gaskets. Provide white finish unless noted otherwise on drawings.
 3. Provide aluminum opposed blade damper with mill finish for all air devices used for exhaust.
- C. Access Core:
1. The grille shall be supplied with an access core on the left or right end of the grille.

2.04 ACCESSORIES

- A. Mounting Frames. Provide each grille or register not equipped with a removable core with a companion, all-purpose mounting frame constructed like a grille frame to facilitate installation and removal of the grille or register without marring adjacent mounting surfaces.
1. Furnish frames with 1/2 inch thick sponge rubber gasket to prevent air leakage.
 2. Provide a frame that neatly fits the grille. Mounting frames will not be required for grilles or registers mounted directly on exposed ductwork.

2.05 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

3.01 INSTALLATION

- A. Do not install ceilings adjacent to fixtures until installation of fixtures, air supply assemblies, return-air blank-off strips and flexible duct have been properly approved. Remove and reinstall any part of the installation found incorrect.
- B. Diffusers. Louvered diffuser outlets mount tight against the ceiling. Fasten outlets securely to ductwork with sheet metal screws. For perforated diffusers, attach the frame assembly by a concealed hinge assembly to an outer frame compatible with the type of ceiling on which the diffuser is installed.
- C. Radial Diffusers. Install per manufacturer's recommendations and as indicated in details. All radial diffusers to be independently hung from structure.

3.02 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 4100 PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.02 RELATED WORK

- A. Section 23 73 13, Air Handling Units

1.03 REFERENCES

- A. AMCA 99 – Standards Handbook.
- B. ARI 850 – Commercial and Industrial Air Filter Equipment.
- C. ASHRAE 52.1 – Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.
- D. ASHRAE 52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size.
- E. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality.
- F. IEST RP-CC—1 – HEPA Filters.
- G. NFPA 70 – National Electrical Code.
- H. SMACNA – HVAC Duct Construction Standards – Metal and Flexible.
- I. UL 586 – High Efficiency, Particulate Air Filter Units.
- J. UL 900 – Test Performance of Air Filter Units.

1.04 DEFINITIONS

- A. IEST – Institute of Environmental Sciences and Technology.
- B. HEPA – High Efficiency Particulate Air.
- C. MERV – Minimum Efficiency Reporting Value.

1.05 SUBMITTALS

- A. Product Data: Include dimensions; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; MERV rating, efficiency and test method; fire classification; furnished specialties; and accessories for each unit indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - 3. Include wiring diagrams.
- C. Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the specified products with minimum three years documented experience, who issues complete catalog data on total product.

- 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. Comply with ARI 850.
- D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.
- E. Comply with NFPA 90A and NFPA 90B.
- F. Filter shall be listed as UL900 per Underwriters Laboratories.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site in accordance with Section 23 00 10, Mechanical General Provisions.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean, dry space and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- D. Ship equipment to jobsite with not less than a prime coat of paint or as specified.

1.08 PROJECT CONDITIONS

- A. Environmental Requirements: Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

1.09 SCHEDULING

- A. Capacities and characteristics are generally shown on schedules on Drawings. Reference shall be made to schedules for such information.
- B. Capacities shown are minimum capacities. Variations in capacities of scheduled equipment supplied under contract will be permitted only with written direction from Owner.

1.10 MAINTENANCE

- A. Extra Materials: Provide two complete sets of filters for each unit. Tag to identify associated unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAF International/Flanders
 - 2. Cambridge.
 - 3. Camfil
 - 4. Koch
 - 5. Dwyer Instruments, Inc.
 - 6. Engineered Filtration Systems

2.02 FILTERS

- A. Filters shall be listed in accordance with UL 900 and shall be tested and reported in accordance with ASHRAE Test Standards 52.1 and 52.2. Dust spot efficiencies listed are results when tested by ASHRAE Standard 52.1. MERV and MERV-A values listed are results when tested by ASHRAE Standard 52.2. and ASHRAE Standard 52.2 Appendix J.
- B. Medium Efficiency Panel Filter (Disposable, Dry Type)
 - 1. MERV 8 Filters:
 - a. Media: 0.18-inch nonwoven cotton and synthetic blend media, formed into a uniform radial pleat. Provide industry standard sizes as required for installation. The minimum media area shall be 17.3 square feet for a 24X24 filter.

- b. Frame: Provide filter media in permanent removable frames with corrosion resistant welded wire grid bonded to the downstream side of the media. Media shall be fully bonded to frame to prevent air leakage.
 - c. Rating: Initial resistance no greater than 0.31-inches w.g. at 500 FPM face velocity. Minimum Efficiency Reporting Value shall be MERV 8, dust spot efficiency of 25-30 percent.
 - d. Thickness: 2-inches or 4-inches. Pre-filters shall be 2-inches unless otherwise noted on the Drawings or Specifications.
- C. High Efficiency Filter V-Bank Filter (Disposable, Dry Type)
 - 1. MERV 11 Filters
 - a. Media: Media: Microfine glass laminated to a reinforcing backing formed into a lofted media blanket with a uniform radial pleat. Pleats media packs shall be assembled into a V-bank configuration with sufficient total media area to meet airflow requirements. Provide industry standard sizes as required for installation. The filter minimum media area shall be 194 square feet for a 24X24X12 size filter.
 - b. Frame: Frame: The media packs shall be bonded to the inside periphery of an ABS enclosing frame with a polyurethane sealant. The enclosing frame shall include top and bottom molded tracks as in integral part of the frame to ensure a proper seal. Rigid plastic end caps shall be mechanically fastened to the top and bottom of the media pack enclosing structure to ensure a rigid and durable filter.
 - c. Rating: Initial resistance no greater than 0.29 inch w.g. at 500 FPM face velocity. Minimum Efficiency Reporting Value shall be MERV 11, dust spot efficiency of 60-65 percent. Thickness: 12 inch thick (nominal) frame.

2.03 FILTER GAUGES

- A. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. Provide vent valves, black figures on white background, front calibration adjustment. The range of the scale shall be no greater than 1" w.g. above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied, 2 percent of full-scale accuracy. Provide with adjustable signal flag.
- B. Accessories: Static pressure tips with integral compression fittings, 1/4-inch aluminum or polymer tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Coordinate filter installations with duct and air-handling unit installations.
- D. Electrical wiring and connections are specified in Division 26 Electrical Sections.

END OF SECTION

SECTION 23 7313 AIR HANDLING UNITS

PART 1 GENERAL

1.01 RELATED WORK

- A. Section 23 05 13, Common Motor Requirements for HVAC Equipment
- B. Section 23 05 15, Variable Frequency Drives
- C. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment
- D. Section 23 05 53, Identification for HVAC Piping and Equipment
- E. Section 23 05 93, Testing, Adjusting and Balancing for HVAC
- F. Section 23 31 13, Ductwork
- G. Section 23 41 00, Particulate Air Filtration

1.02 PERFORMANCE

- A. Unit capacities and characteristics are scheduled on drawings. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit, with clearances as required for maintenance, access and coil pull.
- B. For fans greater than 5 HP, the fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers' certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

1.03 QUALITY ASSURANCE

- A. Fan Performance Ratings: Conform to AMCA 210 or 211 and bear the AMCA Certified Rating Seal for the type of fan specified.
- B. Sound Ratings: AMCA 301; tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.
- D. Filter Media: ANSI/UL 900 listed, Class I or Class II.
- E. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with AHRI 410.

1.04 STRUCTURAL REQUIREMENTS

- A. Provide factory assembled units. Large units may be shipped in assembled sections. Provide rigging hooks for the non modular units. Provide additional bracing for large unit casing as required for structural integrity.
- B. Furnish units with sealing and fastening hardware supplied by the manufacturer. Include written instructions needed to complete field assembly of the components.
- C. Provide units designed and constructed so that coils, fan housings, and fans can be removed without affecting the structural integrity of the unit.

1.05 SUBMITTALS

- A. Submit shop drawings and product data.
- B. Product data shall include complete description of air handling unit construction, including weights (dry and wet) materials of construction, material thicknesses and finishes, insulation thickness and "K" values, fan performance including fan curves, motor electrical characteristics, capacities, ratings, energy recovery device performance data, and coil performance data.

- C. Shop drawings shall include complete unit assembly, dimensions, wet operating weight loading at support points, required clearances, construction details, access door dimensions, and field connection locations and sizes for both coil, condensate and duct connections. Separate section drawings are not acceptable. Indicate locations of factory mounted electrical junction boxes and disconnect switches.
- D. Show compliance in submittal with this specification and other relevant specification sections.
- E. Submit fan curves with specified operating point clearly plotted and at scheduled RPM. Fan performance shall include the effects of inlet screens, safety screens and other system effects. Fan curves shall include the unit operating with the total number of scheduled fans operating at rated capacity and with one failed fan operating at rated or at maximum capacity.
- F. Provide the fan's fan efficiency grade (FEG), peak total efficiency and operating efficiency as defined by AMCA 205.
- G. Submit sound power levels for fan outlet, inlet and casing radiation at rated capacity.
- H. Submit product data of filter media, filter performance data, filter assembly and filter frames showing compliance with the Particulate Air Filtration specification.
- I. Submittal shall include dimensional drawing of insulated condensate drain piping including cleanable trap for each air unit.
- J. Provide information on fan airflow monitoring stations. Submit calibration curves prior to unit shipment.
- K. Provide electrical wiring diagrams. Clearly indicate components that are factory wired and field wired.
- L. Contractor shall submit 1/4 inch scale drawing of each mechanical room for review by owner and engineer. Drawing shall show coil pull spaces and coordination of all ductwork, all chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room. Provide plan and elevation views detailing installation.
- M. Contractor shall submit plan indicating methods for Delivery, Storage and Handling of Air Handling Units prior to shipping of units.
- N. After completion of the factory and/or field deflection and leakage testing, submit the results of the testing for review and approval.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under the Mechanical General Provisions specification.
- B. Include installation instructions, assembly views, lubrication instructions and replacement parts list.
- C. Provide tab for each air handling unit provided.
 - 1. Include copy of approved submittals (with all comments corrected).
 - 2. Include factory or field vibration test results for fans, drives, and motors if specified.
 - 3. Provide copy of calibration curve for each fan airflow monitoring station.
 - 4. Provide copy of any leakage or deflection test results performed during the project.
 - 5. Provide copy of manufacturer's AHU Inspection report.
 - 6. Provide copies of the certified factory balance reports for each air handling unit fan assembly.

1.07 EXTRA FILTERS

- A. For each air handling unit, provide the following spare filters at project completion:
 - 1. Two sets of MERV 8 Filters.
 - 2. One set of MERV 11 Filters

1.08 DELIVERY, STORAGE AND HANDLING

- A. All handling and storage procedures shall be per manufacturer's recommendations and these specifications. Refer to Part 3 of this specification for additional information.
- B. During shipment, it's the responsibility of the manufacturer to ensure AHUs are wrapped with a tight sealing membrane, including electrical components. Wrapping membrane shall cover entire AHU during shipping regardless of size or shape. Units shall be protected against rain, snow, wind, dirt, road salt/chemicals, rust and corrosion.
- C. Coordinate delivery of units with project schedule. Units may not be stored outside and exposed to elements (even if under protective tarps). Store units protected from weather inside building or a warehouse and under protective tarps. Units shall be protected from rain and other sorts of moisture while in transit and on-site.
- D. Storage procedures and protection shall be approved by Owner and Engineer as indicated under Submittals.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products of Manufacturers listed below complying with each of the requirements of the specifications are acceptable:
 - 1. Trane
 - 2. Climate Craft
 - 3. Temtrol

2.02 FABRICATION AND DESIGN

- A. Fabricate units with fan and coil sections plus accessories, including heating coil sections, filter section, cooling coil section as scheduled.
- B. Factory fabricate air handling units of sizes, capacities and configuration as indicated and specified. See drawings for additional information on component layouts.
- C. Base performance on sea level conditions.

2.03 CASING

- A. Construction:
 - 1. Casing shall be constructed of double wall galvanized steel side, roof, and floor panels, not lighter than 24 gauge inner panel with 20 gauge outer panel.
 - 2. Floors shall be of thermal break construction.
- B. Insulation: Provide foam insulation as indicated below. All panels (roof, walls, floor) and access doors shall have a minimum thermal resistance, R of 18 (Hr-ft²-F/BTU):
 - 1. Foam Insulation: Unit shall be completely insulated throughout the entire unit, with all panels and structural frame members insulated with a minimum 3 inches of foam insulation.
- C. Finish: Minimum G60 galvanize finish on all parts of the unit, both inside and out, including supports. Apply manufacturer's standard two-coat enamel finish to exterior. Coating shall pass ASTM B-117 1,000 hour salt spray test.
- D. Thermal Break:
 - 1. A thermal break shall be provided throughout the entire wall assembly that ensures no member on the exterior of the unit, including fasteners, has through metal contact with any member on the interior of the unit, including fasteners.

2. Under scheduled supply air temperature and design conditions on the exterior of the unit of 79°F dry bulb and 73°F wet bulb, condensation shall not form on the casing exterior. The AHU Manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU Manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior under the scheduled supply air temperature and design conditions on the exterior of the unit of 79°F dry bulb and 73°F wet bulb. The guarantee shall note that the AHU Manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. Copies of the guarantee shall be provided to the Engineer and the Owner.
- E. Provide an additional 0.125 inch aluminum diamond tread plated liner walk-on surface in unit access areas (sections with access doors) for all units with supply CFMs greater than 10,000 CFM.
- F. Base Rail.
 1. Provide continuous structural base rail channels beneath unit assembly for structural rigidity of assembly. Provide 6 inch minimum welded structural steel C-channel or A500 structural tubular steel (formed or mechanically fastened bases are not acceptable). Vertical and horizontal unit sections supporting fan sections, coil sections or other unit components shall be designed to support loads without deflecting the perimeter base or sections. The manufacturer shall submit data in accord with Submittals in Part 1 above indicating support points of unit assembly.
 2. Base rail height shall be calculated to confirm that the unit height is sufficient for condensate trapping. Air handler support base shall elevate condensate drain connection not less than 12 inches above finished floor. Unit is to be installed on 6-inch nominal concrete housekeeping pad with drains piped to floor drain.
- G. Access:
 1. Provide access to entry for sections of the unit by full height (max 72" tall) hinged access doors big enough to permit access to and removal of internal parts and entry for cleaning.
 2. Access door insulation shall be same thickness as that of air handling unit walls. Provide full perimeter gasketing on the door or casing to seal access panels. Access doors shall be thermally broken to prevent condensation.
 3. Provide fan, filter, and coil section with access doors with latches, hinges, and exterior and interior handles as manufactured by Ventlock, Allegis, Southco or approved equal. Individual handles shall be provided at each point of door frame engagement.
 4. Minimum length for cooling coil section shall be 36 inches and for heating section 24 inches including access sections. Refer to drawings for additional information on access locations. Provide access sections as indicated on AHU Component Diagrams on the Construction Documents. Provide an access section with a door on left and right side of filter section, unless otherwise specified on drawings.
 5. Minimum clear width of door shall be 18 inches at coil sections (upstream and downstream of cooling and heating coils).
 6. At fan sections, minimum clear width of door shall be 24 inches and large enough to remove the fan and motor.
 7. Access doors shall open against pressure, unless indicated differently on the AHU Component Diagram. For positively pressurized sections where inward swinging doors cannot be provided, the access doors shall include a secondary safety latch.
- H. Windows: Provide viewing window in access doors in all sections. Windows shall be double-pane tempered glass with a thermal break between the outer frame and inner frame to prevent condensation, installed in the door at a height between 4.5 to 5.5 feet above mechanical room finished floor or finished roof.
- I. Coil Connections Panels: Provide removable panels through which piping may pass. Use rubber grommets to seal airtight around pipes on inside and outside of units.

- J. Test and Balancing Ports. Provide a permanent factory-installed sealable port on each section of unit to allow for testing and balancing of system, except where port would be blocked by filters or coils. TAB ports may be located in the access doors of the unit.
- K. Leakage and Deflection Requirements:
 - 1. Leakage requirements: The unit shall be constructed for an allowable casing and fan wall leakage of 1% of the rated unit airflow at a total static pressure of ± 8 inch w.g. Provide statement of compliance with submittal that unit is constructed to meet this requirement. Provide factory installed blank off plates for each fan.
 - 2. Deflection requirements: The unit shall be constructed so the maximum panel deflection shall not exceed an L/240 ratio when tested at a total static pressure of ± 8 inch w.g. 'L' is defined as the height of the unit on the sides, width of the unit on top panels and the smaller of width or height for the ends. Provide statement of compliance with submittal that unit is constructed to meet this requirement.

2.04 FAN SECTION – FAN ARRAY FANS:

- A. The multiple fan array systems shall include multiple, direct driven, arrangement 4 plenum fans as indicated in the drawing schedules and component diagrams. Fan quantities listed in the fan schedule are the minimum quantities of fans required for each unit. All fan arrays shall meet the maximum brake horsepower and total motor horsepower values scheduled. All fans shall be constructed per AMCA requirements for the minimum duty specified class II.
- B. Fan selection shall be made so that if one fan becomes inactive the remainder of the fans will not operate in the surge region. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Fan speed shall be able to be increased 10% without exceeding the maximum fan RPM.
- C. Multiple SWSI Plenum Fan Assemblies. The fan array shall consist of multiple plenum fans and motors spaced in the airway tunnel cross section to provide a uniform air flow and velocity profile across the entire airway tunnel cross section and components contained therein.
 - 1. Inlet panels shall be of heavy-gauge reinforced steel construction. The inlet panel incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel.
 - 2. Plenum fans installed in walk-in units shall be provided with a safety cage around the wheel or with a fan shut down switch in the access doors of the fan section and section upstream of the fan section. Cage shall be large enough to allow working room for wheel and bearing service and shall have removable sections to allow wheel removal. If safety cage is provided, include the pressure losses due to the cage in the internal static pressure calculation.
 - 3. Plenum fan and motor assemblies shall be mounted on a structural steel frame.
 - 4. Statically and dynamically balance each fan, motor, and drive assembly over entire speed range. Air handling unit fans, motors, and drive assemblies shall be balanced to meet AMCA Standard 204-96, exceeding category BV-3, to meet or exceed ISO 21940 balance grade G6.3 or to a maximum of 7 mil peak to the horizontal and vertical plane as measured at the fan mounting leg. Filter out measurements shall be taken in the horizontal and vertical and axial planes. Measurements shall not exceed 10 mils horizontally, vertical planes and axial planes.
 - 5. Provide internal vibration isolators as specified in the Vibration Isolation for HVAC Piping and Equipment specification. Completely isolate entire fan and motor assembly.

- D. Backdraft dampers. Each fan shall be provided with a 304 stainless steel or aluminum counterbalanced gravity back flow prevention device (isolation damper) that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention device(s) shall be included in the criteria for TSP determination for fan selection purposes and shall be indicated as a separate line item SP loss in the submittals. Backdraft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow for any disabled fan and that is mounted directly at the inlet of each fan. Submitted fan performance data which only reflects published performance for individual fans in AMCA arrangement "A" free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with backdraft damper effects included.
1. Gravity Backdraft Dampers: Each damper shall be equipped with an adjustable, weighed counter balance to minimize static pressure loss.
- E. Wheels:
1. Provide single width single inlet (SWSI) plenum fans. All SWSI plenum fans shall have airfoil blades, flat blades are not acceptable. Fan blades shall be continuously welded to the backplate and inlet shroud.
 2. Coat all non-aluminum fan parts with enamel paint; all fan wheel hardware and fasteners shall be zinc plated, cadmium plated, or stainless steel.
- F. Drive:
1. Provide direct drive fans only with the fan wheel mounted to the motor shaft. Fans may be selected with a 1200 rpm, 1800 rpm, or 3600 rpm motor. For 1200 and 1800 rpm motors, the design point must be within the range of 50-90Hz. For 3600 rpm motors, the design point shall be between 50-60Hz.
- G. Fan Arrays with VFDs:
1. Motors:
 - a. Provide motors rated for "inverter ready" and shaft grounding rings per the Common Motor Requirements for HVAC Equipment specification.
 - b. Provide fan motors that will not overload when scheduled fan rpm is increased 10 percent. Submit a fan curve for each scheduled unit showing operating points at scheduled conditions and at scheduled rpm increased 10 percent. Minimum motor sizes as scheduled must be provided without exception. Where larger than scheduled motor sizes are provided, the mechanical contractor shall provide motor VFD, conduit, wiring, disconnect, etc. suitable in accordance with NEC as required for increase in motor nameplate horsepower.
 2. The VFDs will be remotely mounted. Refer to the AHU schedule for the quantity of VFDs and motors, and the wiring arrangement (single VFD/fan or VFD serving multiple fans).
 - a. On AHUs with a VFD serving multiple fans:
 - 1) Motors shall be factory wired to a motor overload panel (MOP) for each VFD. The MOP shall be a NEMA-1 control panel and shall be mounted on the exterior wall panel of the fan array section. Each MOP panel shall have a single point of connection.
 - 2) The MOP shall include for each motor circuit a control device providing overload protection, short circuit protection, and a manual lockable disconnect means.
 - 3) All circuits shall be wired to a common main panel terminal block.
 - 4) All motors will be controlled in unison, maintaining a consistent and uniform airflow pattern over coils, filters, and other devices.
 - 5) All motors shall have a separate, full size, ground wire from the unit terminal block inside the motor overload panel, to each motor, no exceptions.
 - 6) The air-handling unit manufacturer shall provide wiring between the motor and the motor overload panel, so that field penetrations are not required for powering the motor.
 - 7) All wiring shall be done in accordance with the latest NEC guidelines.

3. All wiring (for motors) shall be 600V rated type MTW/THWN stranded copper in EMT, plenum rated metallic (galvanized) flexible, or LiquidTite conduit (max 3 feet).
4. For all electrical penetrations, seal conduit and wiring connections at motor and junction box/motor overload panel air tight to prevent condensation within motor and junction box/motor overload panel and conduit. Isolate junction box/motor overload panel as required to prevent sweating.

2.05 AIRFLOW MONITORING (MEASURING) STATION

- A. For each air handling unit fan (supply fan, exhaust fan, etc.), provide a piezometer ring airflow measuring system. The system shall consist of a piezometer ring mounted on the throat (inlet venturi) and a static pressure tap mounted on the face of the inlet cone. The piezometer ring shall consist of multiple pressure taps on the inlet venturi and piped to a termination plate inside the air handling unit for field supplied differential pressure transducer per the Instrumentation and Control for HVAC specification.
- B. The airflow monitoring station shall have an accuracy of 5% of actual flow. Manufacturer shall verify accuracy of each airflow measuring station with fan isolation damper mounted on the inlet of the fan.
- C. The airflow monitoring station shall provide no resistance to airflow. Probes installed in the fan inlet venturi which restrict airflow are not allowed.
- D. Probes shall be constructed of aluminum, with 1/4 inch nylon tubing utilized between taps and termination plate.
- E. Termination plate shall utilize 1/8-27 NPTF connections and mounted on fan structure.
- F. Manufacturer shall provide all calibration curves for airflow monitoring stations prior to unit shipment.

2.06 COIL SECTIONS

- A. Standards: Supply products of leading manufacturers with dependable published ratings, or equal. Certify performance in accordance with latest edition AHRI Standard 410. Submit coil descriptive literature and rating information for review.
- B. Provide each coil section with access doors as defined in Part 2 of this specification and where indicated in the AHU component drawing.
- C. Enclose coils with headers and return bends fully contained within casing. Each coil shall be individually removable from stainless steel tracks. Where coils are "multiple stack", each coil shall be able to be removed without removing other coil. Air gap between stacked coils is not acceptable. Access panel shall be removable to allow for removal of coil.
- D. Fabrication: Construct coils of copper tubes with fins bonded to the tubes.
 1. Mount in a stainless steel casing permitting removal of coil from unit.
 2. Fins may be either plate type, with tubes mechanically bonded into the fins, or ribbon type, helically wound on individual tubes. Provide a tight, mechanical bond between fins and tubes. Use a minimum of six and a maximum of eleven fins per linear inch of tube.
 3. Design coil section to prevent condensate carryover at face velocities of 500 FPM: Provide minimum coil face area or maximum face velocity as scheduled.
 4. Each coil may only have a single supply and return connection. The maximum height of a single coil is 60-inches. Any unit requiring a cooling coil greater than 60-inches tall shall utilize a stacked coil, with each coil having a supply and return connection. Each coil shall be removable as indicated above.
- E. Drain Pans: Provide a minimum 16 gauge, Type 304 stainless steel double-bottom IAQ type drain pan with minimum 2 inch thick uncompressed insulation in the sealed space between two pans. Extend the drain pan a minimum of 18 inches from the downstream face of cooling coil. Provide coil section access door to drain pan for inspection and cleaning.
 1. Inside chilled water coil section pan shall be all-welded stainless steel construction, with slopes in two directions towards condensate connection for complete drainage of condensate. IAQ drain pan is required.

2. Provide a stainless steel large threaded drain connection on side at the low point of the chilled water pan. Coordinate the condensate drain location with project drawings.
 3. When two or more cooling coils are used, with one stacked above the other, individual drain pans of stainless steel, with copper or stainless steel drains piped to the main drain pan shall be provided beneath each of the coils.
 4. Provide walkable grating in drain pan section with a non-skid surface and meets 25/50 Fire Spread/Smoke Development Rating per ASTM E84.
- F. Chilled Water Coils:
1. Balance the circuits for equal pressure drop of no more than 20 feet on coils.
 2. Arrange each circuit for counter flow cooling with bottom supply connections. Provide drain and vent connections at bottoms and top. Locate coil headers at the same end of the coil.
 3. Select water coil for approximately 3 to 4 feet per second velocity (2 fps minimum, 5 fps maximum).
 4. Provide 1/2 inch or 5/8 inch diameter tubes with minimum 0.020 inch tube wall for 1/2 inch tubes and 0.025 inch tube wall for 5/8 inch tube.
 5. Provide 0.008 inch aluminum fins.
 6. Each coil shall be tested at the factory under water at not less than 250 psi air pressure and shall be suitable for 200 psi working pressure. Submit data indicating tube wall thickness at straight and all U-bends.
 7. Supply and return connections shall be clearly and permanently identified.
- G. Hot Water Coils: Design and construct heating water coils and heating coil sections the same as cooling coils.

2.07 FILTER SECTION

- A. Refer to Specification 23 41 00, Particulate Air Filtration for filter requirements.
- B. Slide Racks. Provide and arrange for filters as indicated on drawings in galvanized filter slide racks to permit easy removal of filters from both sides of filter section. Filter racks shall be separated by a minimum of 1-inch to allow for installation of filter gauge tube. Provide filter access doors on both left and right side of unit. Filter access section shall be sized as required to house filters specified. Filter access doors shall be sized as required for removal of all filters in the unit.
- C. Front Loading Pre-Filter and Primary Filter Racks. Where indicated, provide and arrange for filters in galvanized filter racks to permit front loading removal of filters. Filter racks shall allow for removal of both sets of filters when specified and be separated by a minimum of 1-inch to allow for installation of filter gauge tube.
- D. Design pleated filtering element for low pressure drop and high efficiency at a maximum net face velocity of 500 feet per minute. The element must also have a high dust load capacity.
- E. Provide commonly stocked filter sizes only (24x24 or 12x24). No special filter dimensions will be allowed.
- F. Provide magnahelic gauge with dry set of contacts for each filter bank in the filter section. Magnahelic gauge shall be connected so it displays the pressure drop across the associated filter bank and as required with the BAS system as indicated in the drawings. Refer to Particulate Air Filtration specification.
- G. Pressure probes shall be installed across each filter bank and not across the entire filter section. AHU manufacturer to provide adequate space between the filters to allow for pressure probes to be installed between the pre-filter and final filter.

2.08 CONTROLS

- A. The air handling units shall be provided with field mounted controls per the requirements of the Instrumentation and Control Devices for HVAC specification. Manufacturer to factory install a 1/2" conduit and junction box in each section for use by controls contractor. Seal connection at junction box and isolate junction box the same as required for motor connections.

2.09 CONVENIENCE RECEPTACLE

- A. Provide 120V GFCI convenience receptacle located near the fan section on the exterior of the unit. Lights and convenience receptacle to be wired independent of any other AHU electrical requirements. All wiring shall be in EMT conduit or galvanized flexible metal conduit. Seal connection at junction box and isolate junction box the same as required for motor connections.

2.10 LIGHTS

- A. Vapor proof LED lights (ceiling or wall mounted at a maximum of 88 inches above floor) shall be provided in each compartment with access doors. Lights shall be controlled by one light switch located at the fan access door as shown on the component diagram. Wire lights to junction box for 120V connection by Division 26. Lights and convenience receptacle to be wired independent of any other AHU electrical requirements. All wiring shall be in EMT conduit or galvanized flexible metal conduit. Seal connection at junction box and isolate junction box the same as required for motor connections.

2.11 DAMPERS

- A. Provide dampers as indicated on drawings. Dampers shall meet the requirements of the Instrumentation and Control Devices for HVAC specification.
- B. Dampers shall be opposed acting for airflow control applications and parallel acting for airflow isolation or as indicated on the drawings.

2.12 OUTDOOR ROOF MOUNTED UNITS

- A. Outdoor air handling units shall meet all the requirements of this specification, with exception of revisions and additions indicated below. Unit shall be an outdoor rooftop unit.
- B. Revision to Paragraph 2.3 CASING:
 - 1. Finish (2.3C). The exterior of the unit shall be completely cleaned prior to application of finished coats. A prime coat shall be applied prior to painting. A finish coat of acrylic polyurethane shall then be applied. Unit finish shall exceed 2,000-hour salt spray test, with (5%) solution without any sign of red rust in accordance with ASTM B-117.
 - 2. Roof seams shall be continuously caulked and covered with formed 20 gauge galvanized seam caps. All panel fasteners shall be secured in such a manner as to prevent fastener penetrations that are exposed to the airstream. The unit shall have a sloped roof to promote drainage of precipitation and prevent standing water. The roof shall have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of 1-1/2 inches to prevent precipitation drainage from streaming down the unit side panels. Units with flat roofs are not acceptable.
 - 3. Exterior casing screws shall be zinc chromate coated.
 - 4. Provide 3/4" openings with grommets between interior wall sections. The openings will be used to run control wiring interiorly for the unit.
- C. Piping Vestibule:
 - 1. Pipe vestibule enclosure shall be the same construction and provided with the same thermal performance as the specified unit casing.
 - 2. Provide a perimeter base rail and/or roof curb under the pipe vestibule(s) that meets requirements for the AHU base rail and/or roof curb.
 - 3. Provide a minimum pipe vestibule depth, as shown on drawings. Pipe vestibule depth is the clear inside dimension from inner pipe vestibule surface to outer unit surface.
- D. Roof Curb:
 - 1. Provide a full-perimeter, gasketed and insulated roof curb. Roof curb shall ship loose for field installation prior to unit placement.
 - 2. The roof curb shall be prefabricated of minimum 18 gage galvanized steel or aluminum, sloped to accommodate roof pitch.
 - 3. The roof curb shall be insulated with 1-1/2", 3 pound fiberglass insulation and include a wood nailor.

4. The roof curb shall be a minimum of 12" tall. Contractor to coordinate with roof insulation and flashing requirements.
- E. Controls and Electrical Enclosure:
 1. Provide insulated controls and VFD enclosure on the exterior of the AHU as shown on AHU component diagrams. The enclosure shall be the same construction and provided with the same thermal performance as the specified unit casing. The enclosure shall be cooled by circulated conditioned air from its associated fan section and shall be suitable for ambient temperatures from -20°F to 135°F.
 2. The enclosure shall be provided with conduit knockouts at the bottom of the enclosure for control and electrical services. All penetrations shall be sealed weather tight.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Delivery, Storage and Handling in Part 1 of this specification for additional requirements. If damage to air handling unit casing, motor or accessories is determined from moisture, the contractor shall replace the damaged equipment with an equal, brand new piece of equipment. Rotate fans periodically as recommended by manufacturer. Provide owner a monthly report indicating date fan rotated for each air unit.
- B. Install in conformance with AHRI 435.
- C. A manufacturer's factory trained and/or factory-employed service technician shall be on site and supervise the assembly of all knockdown air handling units for the project.
- D. Assemble units in accordance with manufacturer's installation instructions. Units shall be protected from dust, dirt, water, and debris during construction.
- E. Install air handling unit modules and base rails on a concrete housekeeping pad of sufficient height to install properly sized condensate drain per Part 1 and 2 of this specification. Provide vibration isolators between the unit base rails and the housekeeping pad as specified in the Vibration Isolation for HVAC Piping and Equipment specification.
- F. Provide clearance at each unit for routine service including the changing of filters, removal of coils, bearing replacement, greasing, opening of access doors, and removal of fans and motors.
- G. Provide flexible connections at duct connections to the unit.
- H. Contractor to field coordinate installation of piping and insulation to allow access doors/panels to fully open. Chilled and heating water piping to coil connections shall be installed to permit operation and maintenance of all valves and pumps from mechanical room floor. Valves shall not be installed at heights greater than seven feet above finished floor. Where multi-coil (stacked) arrangement is used, provide each supply and return line to and from each coil section with a union, thermometer well, valve for balancing and isolation valves as indicated on details.
- I. Piping:
 1. Install di-electric flange kits on both coil water supply and return connections.
 2. Support piping independently of coils and with adequate flexibility to prevent undue stress at coil header connections.
 3. Install drain lines from the drain pan connection and include trap to permit condensate to drain freely. The drain line size shall be the larger of what is indicated on the drawings and the drain connection size.
 4. Install service valves on both supply and return lines to coils and install so from the mechanical room floor, valves can be operated, shut off, a small section of pipe removed, and coil allowed to slide out.
- J. Any openings made in the units for addition of controls components shall be sealed air tight, both inside and out. No insulation shall be exposed to the airstream.

- K. For units provided with a fan shutdown switch in the access doors, wire the access door switches to the safety shut down in the VFD, micro-VFD cabinet, or EC motor control panel.
- L. Do not operate units for any purpose, temporary or permanent, until interior of ductwork and air handling unit is clean, filters are in place, bearings lubricated, fan has been test run under observation and Owner's permission is received.

3.02 START-UP TESTING

- A. AHU Inspection:
 - 1. A manufacturer's factory-trained and/or factory-employed service technician shall perform an inspection of each unit and installation prior to startup. The technician shall inspect and verify the following as a minimum:
 - a. Damage of any kind.
 - b. Installation in accordance of the manufacturer's requirements.
 - c. Proper reassembly and sealing of unit segments at shipping splits.
 - d. Removal of shipping bolts and restraints.
 - e. Sealing of piping, controls and electrical penetrations.
 - 2. The manufacturer's technician shall provide a report to the A/E and Owner summarizing any problems found and correction recommendations.
- B. Deflection and Leakage Testing (Field):
 - 1. Unit shall be prepared and tested for leakage and deflection after assembly.
 - 2. Testing shall be conducted by the manufacturer' factory authorized trained technician on site with the aid of the Contractor. The testing shall be witnessed by the owner's representative, engineer's representative, and TAB Contractor.
 - 3. Testing Procedure
 - a. AHU Preparation
 - 1) Assemble and seal AHU sections per manufacturer's installation manual.
 - 2) Close and latch access doors. No additional sealing is permitted.
 - 3) Seal duct and damper openings.
 - 4) Blank off and seal fan openings.
 - 5) Blank off and seal fan bulkhead to isolate positive and negative pressure sections.
 - 6) Factory installed blank off plates are to remain in place throughout installation and testing. Remove plates after leakage testing.
 - b. Pressurization procedure
 - 1) Pressurize positive pressure side to specified static pressures using a pressure blower. Measure and monitor differential pressure exerted on the cabinet with a pressure gage and measure the leakage.
 - 2) Pressurize negative pressure side to specified static pressures using a pressure blower. Measure and monitor differential pressure exerted on the cabinet with a pressure gage and measure the leakage.
 - 3) The leakage rate for the AHU shall be the sum of the measured leakage rate from the positive and negative sides of the unit, including fan wall leakage.
 - 4) Measure the panel deflections at the centers (length and width) of four panels chosen by the owner.
 - 4. If the tested unit does not pass the leakage and deflection requirements outline in Part 2 of this specification section:
 - a. The manufacturer shall provide written instructions to the owner on how to address the issues. The procedure shall be approved to the owner and the unit shall be repaired and retested at the Contractor's expense.
 - 5. Provide test data and results in complete report for Owner and Engineer.

END OF SECTION

SECTION 23 8219
FAN COIL UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies vertical fan coil units for exposed installation.

1.02 SUBMITTALS

- A. Product Data: Include rated capacities, operating 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. Field quality-control test reports.
- D. Operation and maintenance data.

1.03 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. Units shall be ARI 440 certified and labeled.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2016, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IESNA 90.1-2016 Compliance: Applicable requirements in ASHRAE/ IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.04 WARRANTY

- A. Provide one (1) year manufacturer's warranty. Include coverage of fan-coil unit and motors.

1.05 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. Fan-Coil-Unit Filters: Install new filters at substantial completion per Part 3 of this specification. Furnish one additional spare filters for each filter installed to be used by Owner after substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide scheduled products by one of the following:
 - 1. Daikin
 - 2. Enviro-Tec, Inc.
 - 3. International Environmental Corporation.
 - 4. Johnson Controls
 - 5. Price
 - 6. Temtrol
 - 7. Zehnder Rittling
 - 8. VTS

2.02 DIRECT DRIVE VERTICAL FAN-COIL UNITS

- A. Cabinet. Construct of heavy gauge galvanized steel panels. All units shall be insulated with 1/2-inch, 1-1/2 pound fiberglass insulation meeting NFPA 90A requirements. Insulate coil and fan sections. Seal insulation edges.

- B. Access. Exposed units shall have fan and filter front access panels attached with quarter turn quick open fasteners for access to service.
- C. Fan. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. Plenum unit fan assemblies shall be easily serviced through an access panel provided.
- D. Motor. Motors shall be 3-speed, single phase, 60 Hz constant-torque Electronically Commutated Motor (ECM) motors with means for potentiometer field adjustment of each speed.
- E. Hydronic Coil. 1/2 inch copper tube, 0.016-inch tube wall thickness, with mechanically bonded aluminum fins spaced no closer than 12 fins/inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220°F. Include manual air vent and drain valve.
- F. Drain Pan. Primary condensate drain pans shall be single wall, heavy gauge stainless steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal. Drain pans on concealed models shall be field reversible for right or left hand connections. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
- G. Filters. All plenum and exposed units shall be furnished with a minimum 1" pleated MERV 6 filter. Filters shall be tight fitting to prevent air bypass. Exposed vertical unit filters shall be easily removable from the front of the unit without the need for tools.
- H. Electrical. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations. The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats. Provide unit mounted disconnect switch.
- I. Controls: All controls, including terminal equipment controller for fan coil unit shall be supplied by Temperature Controls Contractor to fan coil unit manufacturer for factory installation.
- J. Options: Refer to FCU Schedule
 - 1. Provide return plenum section for return duct connection.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fan-coil units to comply with NFPA 90A.
- B. Install units with vibration isolators as specified in Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
- C. Verify locations of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Install new filters in each fan-coil unit at Substantial Completion.
- E. For units located above ceilings, provide a 22 gage galvanized steel auxiliary drain pan mounted below the entire unit and primary drain pan. Pipe auxiliary drain as indicated on details.
- F. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

- G. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 23 33 00, Air Duct Accessories. Comply with safety requirements in UL 1995 for duct connections.

3.02 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 8243
ELECTRIC DUCT HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes duct mounted electric heaters.

1.02 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- 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. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Equipment schedules to include rated capacities, furnished specialties, and accessories.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.03 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers or coverings, with factory-installed shipping skids. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Check and maintain equipment frequently to ensure it is stored in accordance with manufacturer's recommended practices. Maintain storage records.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacturer of products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck
 - 2. Indeeco.
 - 3. Markel Products, Co.
 - 4. Warren HVAC

2.02 MATERIALS

- A. Heater:
 - 1. Provide electric duct heaters of types, sizes, ratings, and characteristics as scheduled on Drawings.

2. Heating Elements:
 - a. Provide open coil of resistance wire, 80 percent nickel and 20 percent chromium, Grade A resistance wire, supported and insulated by floating ceramic bushings.
 - b. Recess bushings into casing opening and fasten to supporting brackets.
 - c. Mount and support in galvanized steel frame.
- B. Casings: Heater casing shall be of the flange type for installation at flanged duct connections. Provide a flanged construction with inside face dimensions matching the exact duct dimensions.
- C. Control Panel: Provide a NEMA 1 rated terminal box on the side of the heater. Contractor to review installation location and determine orientation of airflow and the electric duct heater and control box to provide manufacturer's required access clearance in front of the control box prior to ordering.
- D. UL Listing: Heater shall be listed by Underwriter's Laboratories for zero clearance to combustible surfaces and for use with central air conditioners. Heaters shall conform to requirements of National Electrical Code.
- E. Primary Protection: Provide disc-type automatic reset thermal cutout for primary over temperature protection.
- F. Secondary Protection: Provide disc-type, load-carrying manual reset thermal cutouts wired in series with each heater circuit. Cutouts shall be rated minimum 480 volts. Heat limiters or other fusible over-temperature devices are not acceptable.
- G. Feeder:
 1. Furnish voltage, phase, and number of heating states per duct heater schedule.
 2. Three-phase heaters shall have single-phase circuits for operation from a 3-phase, 4-wire power source.
 3. One set of line terminals shall be furnished to feed all circuits.
 4. Size field-installed conductors feeding the heater for 125 percent of connected load.
- H. Built-in Features:
 1. Factory wire built-in features to terminal blocks for field connection.
 2. Insulate internal wiring for 105°C.
 3. Built-in magnetic contactors shall disconnect ungrounded conductors to each circuit.
 4. Furnish heaters with an air flow switch which will not allow heaters to energize without proof of air flow.
 5. Built-in controls transformer shall be provided.
 6. Duct heater overcurrent protection shall be factory installed per NEC 424-22(b) and (c), and shall be UL Class RK-5 time-delay, current limiting type with rejection features.
 7. Fuse clips for the fuses shall have rejection features per UL Class R requirements.
 8. Provide built-in unfused disconnect switch and shall be snap action, industrial type.
 9. Door interlock mechanism to prevent hinged terminal box cover from being opened when the switch is on.
 10. Provide SCR type controls to modulate the entire heater load from 0 to 100% of the total heater kW.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Inspect areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Install electric duct heaters in accordance with manufacturer's instructions, and contract construction drawings.
- C. Do not operate electric duct heaters until ductwork is clean of any debris.
- D. Install electric duct heaters and casings in accordance with SMACNA Edition 1995 "HVAC Duct Construction Standards".

- E. Connect duct heaters and components to wiring systems and to ground as indicated and instructed by manufacturer.
- F. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
- G. The heater shall not be installed closer than 4' downstream or upstream from a fan outlet, abrupt transition, or other obstructions. Elbows or turns must be located at least 4' from inlet of the heater and 2' from outlet of heater. If such an installation cannot be avoided, provide a pressure plate upon engineer's approval.
- H. Install electrical heater in a location which will provide NEC required clearances of 42" minimum in front of terminal box. In addition, allow at least 5" of free air space around the cooling fins on the SCR power controller.
- I. For flange type heaters, heater shall be held in place with bolt and nuts through the flanges. Seal edges of flanges to maintain pressure rating as indicated for ductwork type installed. Refer to 23 31 13 for Ductwork Pressure Classifications. For outdoor installations, a RTV silicone rubber shall be applied along all mating surfaces and bolt holes to seal watertight.

END OF SECTION

**SECTION 26 0000
ELECTRICAL GENERAL PROVISIONS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.
- B. New Work. The work includes, but is not limited to, the following principal systems and equipment:
 - 1. 480/277 and 208/120 volt distribution.
 - 2. Panelboards-Distribution, Branch Circuit and Electronic Grade.
 - 3. Transformers-General purpose, K-factor, and Harmonic Cancelling.
 - 4. Luminaires, poles, lamps and ballasts.
 - 5. Fire alarm system.
 - 6. Lighting controls.
 - 7. Lighting control system.
 - 8. Grounding and bonding system.
 - 9. Motor controllers.
 - 10. Variable frequency drives for AC electric motors. Furnished by Division 23, installed by Division 26.
 - 11. Electric motors. Furnished and installed by Divisions 21, 22 and 23. Electrical connections by Division 26.
- C. Empty Raceway. Refer to Division 27 telephone/data and Division 28 security specifications for cabling requirements. Provide empty raceway for the following systems per ANSI/TIA-569-C:
 - 1. Communications: Computer system cables and outlets. Refer to telecommunications Drawings for additional work.
 - 2. Communications: Telephone system cables and outlets. Refer to telecommunications Drawings from additional work.
 - 3. Security system cables and devices. Refer to Security Drawings for additional work.
- D. Demolition. Refer to demolition Drawings and Section 26 0001 for scope of work.

1.02 APPLICABLE PROVISIONS

- A. Provisions Specified Elsewhere. Unless modified in this Section, General and Supplementary General Conditions, applicable provisions of Division 01 - General and other provisions of contract documents apply to work of Division 26 - Electrical.
- B. Application. Provisions of this Section apply to every section of Division 26 - Electrical, except where specifically modified.
- C. Work covered by this Section shall be accomplished in accordance with applicable provisions of the Contract Documents and addenda or directives which may be issued herewith, or otherwise.

1.03 RELATED WORK

- A. Existing Conditions - Division 02.
- B. Site Work – Division 02.
- C. Concrete - Division 03.
- D. Sealing and Firestopping – Division 07.
- E. Openings - Division 08.
- F. Finishes - Division 09.
- G. Equipment - Division 11.

- H. Furnishings – Division 12.
- I. Special Construction – Division 13.
- J. Conveying Equipment – Division 14.
- K. Fire Protection – Division 21.
- L. Plumbing – Division 22.
- M. Heating, Ventilation and Air Conditioning – Division 23.
- N. Communications – Division 27.
- O. Electronic Safety and Security – Division 28.
- P. Utilities – Division 33.

1.04 REFERENCE CODES AND STANDARDS

- A. Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.
- B. Association of Edison Illuminating Companies (AEIC).
- C. American National Standards Institute (ANSI).
- D. Institute of Electrical and Electronics Engineers (IEEE).
- E. Insulated Cable Engineers Association (ICEA).
- F. National Electrical Code (NEC).
- G. Denton Electrical Code
- H. National Electrical Manufacturers Association (NEMA).
- I. National Electrical Safety Code (NESC).
- J. National Fire Protection Association (NFPA).
- K. Underwriters' Laboratories (UL).
- L. ASHRAE/IESNA 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.05 REGULATIONS AND PERMITS

- A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:
 - 1. National Electrical Code (NEC).
 - 2. Denton Electrical Code
 - 3. National Electrical Safety Code (NESC).
 - 4. Occupational Safety and Health Act (OSHA).
 - 5. Americans with Disabilities Act (ADA).
 - 6. Texas Department of Licensing and Regulation (TDLR).
 - 7. Texas Occupational Code.
 - 8. Texas Electrical Safety and Licensing Act – Title 8, Occupations Code Chapter 1305.
 - 9. State and federal codes, ordinances and regulations.
- B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing, including a proposed resolution, and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.
- C. Permits: Obtain certificates of inspection and other permits required as a part of the work. Submit written evidence to the Owner's Representative and Architect/Engineer that the required permits and inspections have been secured.

1.06 DRAWINGS AND CONTRACT DOCUMENTS

- A. Intent: The intent of the construction Drawings or contract documents, hereinafter referred to as the "Drawings", is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. The Drawings, specifications, and related contract documents are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Electrical Drawings, are generally diagrammatic and show approximate location and extent of the work. Review pertinent Drawings and adjust the work to conditions shown. Install the work complete, including minor details necessary to perform the function indicated.
- B. The Contractor shall carefully investigate structural and finish conditions, and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceways, subject to prior review by the Owner's Representative. Work shall be organized and laid out in finished portions of the building so that it will be concealed in furred chases, suspended ceilings, and similar elements of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner's Representative in writing, requesting an interpretation, and include a proposed solution.
- D. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- E. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner's Representative proposed changes in outlet and equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner. Remove and replace outlets placed in unsuitable locations, when so requested by the Owner's Representative, and at no additional cost to Owner.

1.07 SUBMITTALS

- A. Submit the following in addition to and in accordance with the requirements of the Uniform General Conditions and in Division 01, Submittals.
 - 1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
 - 2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions are clearly indicated and non-applicable portions clearly deleted or crossed out.
 - 3. Schematic, connection and/or interconnection diagrams.
 - 4. Provide submittals as required by individual specification section.
- B. Provide the following with each submittal:
 - 1. Catalog cutsheets with manufacturer's name clearly indicated. Applicable portions shall be clearly indicated by arrows, circles, or similar markings and non-applicable portions shall be clearly deleted or crossed out.
 - 2. Line-by-line specification review by equipment manufacturer and contractor with exceptions explicitly defined.
 - 3. Itemize and organize equipment and material submittals by specification Section number; include manufacturer and identifying model or catalog numbers.
 - a. Submittal packages for product data, shop drawings, and other required submittals shall be numbered sequentially according to the applicable specification Section number. For example, the first submittal package for Energy-Efficient Dry-Type

Transformers shall be identified as Submittal number 262213-01. The second submittal package for Energy-Efficient Dry-Type Transformers would be identified as Submittal number 262213-02. Re-submittal packages shall be identified by an "R" in the sequential numerical suffix.

- b. Where directed by the Owner or the Architect to combine submittals into a common package, the submittal data may be organized in one or more 3-ring binders or similar container. Product data, shop drawings, and other submittal data shall be organized in separate tabs according to paragraph 1.07B.3a, above. That is, submittal data in individual tabs of a common submittal package shall be numbered sequentially, according to the applicable specification Section number.
 4. Replace rejected items and resubmit with acceptable items in accordance with the requirements of Division 01 for Submittals, and with the Uniform General Conditions.
- C. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
1. Itemize equipment and material by specification section number; include manufacturer and identifying model or catalog numbers.
 2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
 3. If a satisfactory replacement is not submitted within a two-week period, Owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to Owner.
- D. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads shall be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.
- E. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also submit the following for review:
1. Electrical and Telecommunications Rooms. Submit 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
 2. Mechanical and Pump Rooms. Submit 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Submit 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.
 4. Corridors. Submit 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
 5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.
 6. Review: The completed "Composite Drawings" shall be submitted to the Architect/Engineer for review prior to installation. Work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost to the Owner.
- F. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner's Representative. Equipment and materials installed prior to acceptance by the Owner/Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.
- G. Startup and Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
 2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
 3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
 4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.
- H. As-Built and Record Drawings:
1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups must be made as the changes are done.
 2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner's Representative, and shall be complete.
 3. Prior to final acceptance, deliver to the Owner's Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-built drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).
 4. Quantity: In accordance with the requirements of Division 01 and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.
- I. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division 01, as applicable.

- J. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 0573. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.08 SUBSTITUTIONS

- A. Refer to requirements of Division 01 for substitution of Material and Equipment.
- B. Product manufacturers are listed to establish a level of quality for the products. Substitutions may be allowed if the product is equal to or better than what is listed in the design guidelines, as determined by the Architect/Engineer and owner's Representative upon submittal of comparison products.
- C. Samples: When requested by the Owner's Representative or the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. When requested, provide samples of both the specified item and the proposed item for comparison purposes.
- D. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. Time periods for Architect/Engineer processing and review of submittal data, shop drawings, samples, studies, and reports shall be in accordance with the applicable submittal and substitution requirements of Division 01 and the General Conditions. The Contractor shall allow sufficient time for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles for processing of submittal data and shop drawings, including time for resubmittal cycles on unacceptable and rejected materials, equipment, components, and systems covered by the data submitted. Construction delays and lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in requests for scheduled construction time extensions and additional costs to the Owner.
- E. Acceptance: Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the Drawings, specifications, and other applicable Contract Documents, and that adequate and acceptable clearances will exist for entry, servicing, and maintenance. Acceptance of materials and equipment under this provision shall not be construed as authorizing deviations from the Specifications, unless the attention of the Owner's Representative and the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless pertinent information is properly identified.
- F. Replacement: Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment originally specified at no additional cost to the Owner.

1.09 CONTRACTOR QUALIFICATIONS

- A. An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system.
 - 1. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.
 - 2. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: "LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter."

- B. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of the Project Safety Manual (PSM).
 - 1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
 - 2. The Contractor shall secure electrical rooms, to limit access, prior to energizing high voltage (1000V or higher) equipment, and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
 - 3. The Contractor shall strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.
- B. NEC and UL.
 - 1. Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
 - 2. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.
- C. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110.26 and Article 110.34 of the National Electric Code (NEC) for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. Scaled drawings (1/4" = 1'-0") of electrical and telecommunication rooms shall be submitted for review by the Architect/Engineer and the Owner's Representative prior to installing equipment. See paragraph 1.07E above.
- D. Factory Finish. Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.
- E. Physical Size of Equipment: Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.
- F. Enclosure: Provide NEMA 1 enclosure for indoor installation and NEMA 4X for outdoor enclosure, unless noted or specified otherwise. The enclosure shall be suitable for the environment per NEC, NEMA and ANSI standards.
- G. Conductors in Conduit: Conductors shall be installed in conduit. Exceptions are listed in individual Sections of the Division 26 and Division 28 specifications.

2.02 MANUFACTURER

- A. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer, except as specifically noted in individual Sections of the specifications.

2.03 SUBSTITUTIONS

- A. Refer to Division 01 section on Material and Equipment, and to paragraph 1.08 of this Section.

2.04 NAMEPLATES AND DEVICE MARKING

- A. Refer to Section 26 0553, Identification for Electrical Systems.

2.05 AUTOMATED EQUIPMENT AND CONTROLS

- A. Equipment and control systems where applicable, shall match, integrate, communicate and cooperate with new and existing systems, such as building automation, energy management, direct digital controls (DDC), fire detection and alarm, circuit breakers, transformers, etc.

PART 3 EXECUTION

3.01 GENERAL

- A. Manufacturer's Recommendations: The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, wiring, and connection of equipment and material. Promptly notify the Architect/Engineer and the Owner's Representative in writing of conflicts between the requirements of the Drawings and specifications and the manufacturer's directions, in accordance with paragraphs 1.05B and 1.06C of this Section. Obtain instructions from the Owner's Representative before proceeding with the work. Should the Contractor perform work that does not comply with the manufacturer's directions or such instructions from the Owner's Representative, he shall bear costs arising in connection with the deficiencies.
- B. Site Observation: Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Drawings, specifications, and other applicable Contract Documents. Site observation by the Architect/Engineer shall not be construed as construction supervision, or indication of approval of the manner or location in which the work is being performed, or as being a safe practice or place. Site observation by the Architect/Engineer shall not be construed as inspection by the Authority Having Jurisdiction (AHJ) or other applicable code enforcement authority.
- C. Installation:
1. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: "LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter."
 2. Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by the Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and the Owner's Representative. Equipment and materials installed prior to acceptance by the Architect/Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.
- D. Supervision:
1. The Contractor of the work under this Division shall keep a competent superintendent or foreman on the job throughout the period of construction. Refer to Division 01 requirements and the Uniform General Conditions for additional information concerning supervision.
 2. It shall be the responsibility of such superintendent to study the Drawings, specifications, and other applicable Contract Documents, and familiarize himself with the work. He shall coordinate his work with other trades before material is fabricated or installed, and ensure that his work will not cause interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the Contractor. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the Architect/Engineer and the Owner's Representative for resolution in accordance with paragraphs 1.05B and 1.06C of this Section.

3.02 PROTECTION OF EQUIPMENT AND MATERIALS

- A. General:
 - 1. The Contractor shall follow the manufacturer's directions completely in the delivery, storage and handling of equipment and materials.
 - 2. Equipment and materials shall be tightly covered and protected against dirt, water, chemical, physical or weather damage and theft. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and shall be returned to "as new" condition.
 - 3. Electrical cable, conductors and equipment shall be stored to prevent moisture and mechanical damage in an area that is protected from wind, rain or other exterior elements. Prior to installation, the building must be "dried-in" to prevent damage as stated above.
- B. Moisture. During construction, protect switchboard, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually. Equipment shall be protected against wind, rain or other exterior elements.
- C. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.
- D. Damage. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- E. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore finishes that become stained or damaged.
- F. Weather. Protect equipment and materials from weather and sunlight by use of suitable coverings and storage indoors, or in suitable weather-protected containers. Materials and equipment marked by their manufacturer as suitable for storage outdoors may be stored according to manufacturer's markings. Maintain factory-installed coverings and wrappings until material is to be installed.

3.03 PREPARATION

- A. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also prepare the following:
 - 1. Electrical and Telecommunications Rooms. Prepare 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

2. Mechanical and Pump Rooms. Prepare 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
 3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Prepare 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.
 4. Corridors. Prepare 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
 5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.
 6. Review: The completed "Composite Drawings" shall be prepared prior to installation. Work that proceeds without appropriate coordination will be subject to removal and relocation at no additional cost to the Owner.
- B. Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
 2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
 3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
 4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

3.04 SAFETY

- A. Implement the following safety procedures in addition to, and in accordance with, the requirements of Division 01 and the Uniform General Conditions:
1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.
 2. Prior to energizing panelboards within the scope of work, secure affected electrical rooms to limit access to line voltage. Line voltage shall be defined as above 50 volts, for the purpose of controlling access. During and after energization of panelboards, control access to electrical rooms for the duration of the project. Post and maintain warning and caution signage in areas where work is on-going near energized equipment. Cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
 3. Strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

3.05 INSPECTION

- A. Examination. Examine the areas and conditions under which equipment and systems are to be installed, and notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Coordination. Carefully investigate structural and finish conditions and coordinate the work in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, suspended ceilings, and similar elements in finished portions of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. Inspections must be called before closing-in any wall for approval of Electrical.

3.06 INSTALLATION

- A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide other trades, as required, templates, patterns, setting plans and shop details for the proper installation of the work and for purposes of coordinating adjacent work. Electrical power connections for mechanical and plumbing equipment are in this Division unless noted otherwise. Verify electrical characteristics of equipment with other Divisions before roughing in the electrical connections.
- B. Workmanship. Work shall be performed by workmen skilled in their trade. The installation shall be complete and installed in a neat and workmanlike manner in accordance with NEC 110.12 and FPM accompanying, and as described in ANSI/NECA 1-2000 "Standard Practices for Good Workmanship in Electrical Contracting" and other ANSI approved installation standards.
- C. Concrete Equipment Pads.
 - 1. Refer to structural Drawings and specifications for design criteria.
 - 2. Where not otherwise indicated, install 4 inch thick reinforced concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 4 inches beyond equipment. Trowel pads smooth with a slope per manufacturer's recommendations and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.
 - 3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment embedded within the concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- D. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
 - 1. Equipment must be leveled and set plumb.
 - 2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.
 - 3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads in accordance with paragraph 3.05C, this Section, except where equipment is noted and designed for mounting directly on the concrete floor slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.
 5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.
 6. Refer to Section 26 0529, Metal Framing and supports, for additional requirements.
 7. Provide permanently marked NEC required clear space in front of and behind electrical equipment. Install markings on the floor using the color scheme conforming to ANSI Z535.1 for black and white striped border. Omit where installed in carpeted areas. Install space clearance labels where floor markings are not practical.
- E. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.
- F. Motors.
1. Motors are specified in Divisions 21, 22 and 23.
 2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
 3. Refer to Division 23 and other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
 4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
 5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.
 6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review. Diagrams will be based on accepted equipment and be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. They will be followed in detail. For additional clarification, refer to Division 23, Controls.
- G. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
 2. Where exposure is necessary to the proper function.
 3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner's Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.
- H. Application. Unless otherwise indicated, power will be utilized as follows:
1. 208 volts, three phase: motors 1 horsepower and larger.
 2. 120 volts, single phase: motors 3/4 horsepower and smaller.
 3. 120 volts, single phase: fan powered boxes.
 4. 120 volts, single phase: decorative lighting.
 5. 120 volts, single phase: fluorescent and high-intensity-discharge lighting.

6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
 7. 208 volts, single and three phase: specialty outlets.
 8. 208 volts, three phase: special power and equipment; verify for each unit of equipment.
- I. Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.
1. Roughing-in: When roughing-in, provide electrical branch circuits to various items of equipment. Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.
 2. Final Connections: Millwork, casework, and similar equipment will include service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment. Provide branch circuit connection to match electrical connection requirements of service fittings.
- J. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, and raceways shall be made to maintain proper headroom. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.
- K. Observation prior to cover-up or seal-in of walls and ceilings. Perform the following in accordance with the applicable requirements of Division 01 and the General Conditions:
1. Prior to the installation of ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner's Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide advance notice in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required, or directed elsewhere, provide not less than 10 working days' advance notice.
 2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.
 3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner's Representative.
- L. Finish. Coordinate with Division 09 to paint exposed conduit to match adjacent walls, unless otherwise directed.

3.07 EXISTING FACILITIES

- A. Responsibility. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and maintenance of electrical services for new and existing facilities. The Contractor shall erect temporary barricades, with necessary

safety devices, as required to protect personnel from injury, removing such temporary protection upon completion of the work.

- B. Services. The Contractor shall provide temporary or new services to existing facilities or equipment as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Access. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaires, air conditioning ductwork and equipment, etc., to provide this access, and shall reinstall same upon completion of work in the areas affected.
- D. Existing Devices. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer devices required for the operation of the various systems installed in the existing construction. This is to include, but is not limited to, temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, etc.
- E. Outages. Outages of services as required by the new installation will be permitted, but only at a time approved by the Owner. The Contractor shall coordinate with the Owner's Representative to arrange for service outages. The Contractor shall allow the Owner sufficient time to schedule for required outages, in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required or directed elsewhere, allow a minimum of 21 working days for the Owner to schedule for required outages. The time allowed for outages will not be during normal working hours or during hours of research and instruction, unless otherwise approved by the Owner's Representative. Costs of outages, including overtime charges, shall be included in the contract amount.
- F. Adjacent Facilities. Coordinate work among the various trades to minimize disruption to existing processes, procedures, and equipment in spaces adjacent to areas of demolition and renovation work. Coordinate with Owner's Representative to schedule work producing noise or structure-born vibrations, including but not limited to cutting, drilling, coring, and use of impact tools.

3.08 EQUIPMENT AND DEVICE MARKING

- A. Designations. Identify equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the Drawings.
- B. Nameplates. Externally mark electrical equipment with nameplates identifying each and the equipment served. Supply blank nameplates for spare units and spaces.
- C. Refer to Section 26 0553 for additional requirements.

3.09 SLEEVES, PENETRATION, CUTTING AND PATCHING

- A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner's Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.
- B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner's Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner's Representative and the Architect/Engineer for each penetration.
- C. Penetrations.
 - 1. This contract requires core drilling of floor or wall penetrations as indicated on Drawings. Core drilling shall be in accordance with structural specifications. Floor penetrations shall

- include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.
2. Penetrations shall be sealed in accordance with the requirements of Division 07, Firestopping. Coordinate with Division 07 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.
 3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.
 4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.
 5. X-Ray the slab prior to core drilling to verify the location of rebar or other structural items in the slab.
- D. Sealing and Firestopping.
1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E814 or UL 1479, in accordance with Division 07 requirements for Firestopping.
 2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 07 to provide removable firestopping system.
 3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250° F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.
 4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter's Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).
 5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.
- E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel except at conduit supports. Sleeves set in concrete floor construction supporting conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 07 specifications.
- F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with "Link Seal" casing seal as manufactured by Thunderline Corporation of Wayne, Michigan. Size conduit sleeve to accommodate the casing seal. Use Series 300 casing seals for pipe 3/4-inch through 4-inch and Series 400 casing seals for pipe sized 5-inch and larger.

- G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner's Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.
- H. Restoration. Restore openings to "as new" condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.
- I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner's Representative.
- J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through beams, joists, slabs, mats, and other structural components and systems prior to forming of those structural components and systems.
- K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 07 – Roofing.
- L. Escutcheons. Provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or accepted substitution, chrome-plated steel plates with concealed hinges.
- M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 07.

3.10 CLEANING, ADJUSTING AND START-UP

- A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer and Owner's Representative, and as required under individual Sections of the Division 26 specifications.
- B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer's instructions for proper functioning during modes of operation, including emergency and shutdown conditions.
- C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.11 TESTING

- A. Test Conditions. Use field startup and testing procedures submitted in accordance with paragraph 1.07H of this Section and accepted by the Owner's Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

- B. Test Conditions. Use field startup and testing procedures prepared in accordance with paragraph 3.03B of this Section. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.
- C. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion date to permit adjustment and alterations within the number of days allotted for completion of the contract. Inform the Owner's Representative in advance of test dates in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required, or directed otherwise, allow a minimum of at least 10 working days advance notice.
- D. Retests. Conduct retests as directed by the Owner's Representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under this contract.
- E. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and commissioning of electrical components and systems.
- F. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with Division 01 requirements.

3.12 OPERATING AND MAINTENANCE MANUALS

- A. General. The Contractor shall provide, in loose-leaf binders, complete operating and maintenance data of each manufactured item of equipment used in the electrical work at least four weeks before Architect/Engineer's final review and observation of the project. Descriptive data and printed installation, operating and maintenance instructions for each item of equipment will be included. A complete double index will be provided as follows.
- B. Format and content. The Operating and Maintenance Manual will be submitted in quantities and format as specified under Division 01 for Submittals. Provide quadruplicate where quantity is not specified. Operating and Maintenance Manual shall include:
 - 1. Descriptive data of each system and piece of equipment, including ratings, capacity, performance data, operating curves and characteristics, and wiring diagrams.
 - 2. Full detailed spare parts list, including source of supply for each piece of equipment. Where spare parts are not recommended by the manufacturer, indicate as such in the appropriate section.
 - 3. Printed instructions describing installation, operation, service, maintenance, and repair of each piece of equipment.
 - 4. Typewritten test and start-up reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.
 - 5. Copies of "Reviewed" shop drawings and submittals.
 - 6. Print copies of the record Drawings. Refer to paragraph 1.07I of this Section.

END OF SECTION

**SECTION 26 0100
DEMOLITION AND WORK WITHIN EXISTING BUILDINGS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of the General Conditions, Supplementary Conditions, Division 01, and Drawings apply to all Work herein.

1.02 SCOPE

- A. Existing buildings and their facilities must remain functional while the Work under this Contract is performed. All system shutdowns and outages must be minimized and coordinated with the Owner.

1.03 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

- A. General: During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace, as required, any damage that might occur because of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
- B. Loss or Damage: The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and in-service maintenance of all mechanical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.
- C. Operational Continuity: The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted because of the work being accomplished under this project.
- D. Utility Access: Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.
- E. Demolition of Architectural/Structural Elements: Where partitions, wall, floors, or ceiling of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- F. Scheduled Service Outages: Outages of services as required by the new installation will be permitted only at a time approved by the Owner. The Contractor shall allow the Owner two (2) weeks to schedule required outages. Outages will not be allowed during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
- G. Pre-Demolition Salvage Survey: The Contractor shall modify, remove, and/or relocate all materials and items so indicated or as required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owner's Representative before demolition begins and determine all materials that the Owner specifically chooses to be salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The

Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

- H. Relocated Equipment: All items that are to be relocated shall be carefully removed in reverse order of original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- I. Damaged Materials/Equipment to be Reused: When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- J. Termination of Utility Services: Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections to the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as above specified.
- K. Nighttime Shifts: Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate times with the Owner.
- L. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems regardless of whether such rerouting, reconnecting, or relocating is shown on the Drawings. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.
- M. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.
- N. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing lighting fixtures, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.
- O. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, switches, other materials and equipment and their appurtenances shall be removed and relocated, if necessary, where required by the remodel work either shown or specified.
- P. Any salvageable equipment as determined by the Owner shall be delivered to the Owner and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- Q. Equipment, materials, or other potential hazards to the public and working occupants of the building shall not be left overnight outside of the designated working or construction areas.
- R. No portion of the fire protection systems shall be turned off, modified, or changed in any way without the express knowledge and written permission of the Owner's Representative.
- S. Refer to Architectural Demolition and Alteration plans for actual location of wall, ceiling, and similar items being removed and/or remodeled.

- T. Drawings do not fully indicate conditions or existing obstructions or utilities. Visit the site and examine work to be removed and become familiar with conditions affecting work.
- U. Asbestos removal is not part of this Contract.

END OF SECTION

SECTION 26 0519 INSULATED CONDUCTORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of insulated conductors.

1.02 REFERENCE STANDARDS

- A. ANSI/IEEE 386 - Separable Insulated Connectors for Power Distribution Systems Above 600 Volts.
- B. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.
- C. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- D. ANSI/UL 2196 "Tests for Fire Resistive Cables"
- E. CSA C22.2 #124
- F. UL Fire Resistance Directory

1.03 SUBMITTALS

- A. Provide product data on the following:
1. 600-volt conductor, splicing and terminating materials.
 2. MI cable

PART 2 PRODUCTS

2.01 IDENTIFICATION

- A. Provide new insulated conductors marked according to NEC Article 310.

2.02 600-VOLT INSULATED CONDUCTORS

- A. Size. As shown on the drawings.
- B. Construction.
1. Conductor. Soft-drawn, annealed copper. Solid for #12 and #10 and Stranded for all other sizes.
 2. Insulation. Unless otherwise noted on the drawings, use THHN/THWN-2 for general wiring. Use XHHW-2 for conductors installed below grade and outdoors.
- C. Use. For general wiring use No. 12 minimum. For field-installed control wiring use No. 14 or larger stranded conductors.
- D. Listing. Single Conductor. UL 83.

2.03 TYPE MI – MINERAL INSULATED CABLE

- A. Size as shown on drawings
- B. Construction
1. Conductor: Solid high conductivity copper
 2. Insulation: 600V, magnesium oxide
 3. Fire Rating: Complex cable system shall have a 2 hour fire rating as used and classified by Underwriters Laboratories, Inc.
- C. Manufacturer: Pentair/Pyrotenax

PART 3 EXECUTION

3.01 INSTALLATION

- A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors, or less than twelve times the outer diameter of the completed 15 kV cable. Do not exceed manufacturer's recommended values for maximum pulling tension.
- B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Current crimping tool certification is required for crimping tools. Use ring-tongue type terminators on all control wiring. Push-in style connectors are not approved for use.
- C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.02 600-VOLT INSULATED CONDUCTORS

- A. Size. Install conductor sizes as indicated.
- B. Home Runs. Provide branch circuit homeruns as indicated on plans. Homerun designations are indicated on Sheet E-001. Provide the number of homeruns as indicated on plans. A maximum of 6 phase conductors may be installed in one conduit. Include a separate neutral conductor with each phase conductor for all 120V circuits. Common neutrals are not permitted. For 277V lighting circuits one neutral conductor may be used for three phase conductors. Use home run circuit numbers as indicated for panelboard connections. For isolated ground circuits provide an additional ground conductor as indicated on the panel schedules. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20 ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120 volt circuits and 200 feet for 277 volt circuits.
- C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

<u>Line</u>	<u>208/120</u>	<u>480/277</u>
A or L1	Black	Brown
B or L2	Red	Purple
C or L3	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Switch Leg	Pink or Violet	Pink or Violet

Where more than one conductor of the same phase or more than one neutral conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. All wiring associated with isolated ground receptacles (line, neutral, ground) shall have a yellow tracer on each conductor.

- D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 26 05 00. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

3.03 TYPE MI – MINERAL INSULATED CABLE

- A. Size – Install conductor sizes as indicated.
- B. Home runs: Install cable per manufacturer's instructions
- C. Color Code/label: Label each individual cable every 5' with the following: 600V 2HR fire rated cable.

END OF SECTION

SECTION 26 0526 GROUNDING AND BONDING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section specifies the furnishing and installing of grounding and bonding equipment for electrical systems.

1.02 REFERENCE STANDARDS

- A. ANSI/IEEE Std 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- B. ANSI/NEMA GR 1-2007 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- C. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
- D. ANSI/UL 467 - Grounding and Bonding Equipment.
- E. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System.
- F. IEEE 1100 - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book).
- G. NFPA 70 - National Electrical Code (NEC).
- H. NFPA No. 780 - Lightning Protection Code.
- I. UL 96A - Master Labeled Lightning Protection System, Installation Requirements.

1.03 RELATED WORK

- A. Section 26 41 00, Lightning Protection System.
- B. Division 27, Communications.
- C. Division 28, Electronic Safety and Security.

1.04 SUBMITTALS

- A. Product Data. Submit product data sheets, including complete descriptive information on materials and installation methods.
- B. Shop Drawings.
 - 1. Provide detailed plans prepared to 1/8-inch scale with 1/8-inch text which indicate the work to be performed. Details of component mounting, and connections shall be included on separate detail drawings. Manufacturer's catalog numbers and generic identification shall be indicated for components shown on the Drawings.
 - 2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., and their compatibility with provisions made during the construction. Once the contract has been established the Contractor shall make a review of provisions being made for the system installation and comment, in writing, with changes or compliance within two weeks of finalizing the contract. Contractor shall coordinate locations of conductors in walls and penetrations with the appropriate trades. Failure to coordinate these requirements shall not relieve this Contractor from properly completing this work. The Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.
- C. Coordinated Submittal.
 - 1. Submit product data and shop drawings for grounding system and lightning protection system at the same time and as one package. Indicate common components and interconnections between grounding and lightning protection systems. Refer to Section 26 41 00 for Lightning Protection System.

2. Coordinate submittal for grounding system with electrical service to building and with electrical service equipment.
 - a. Refer to Section 26 00 05 for electrical service.
 - b. Refer to Section 26 13 15 for 15 kV Class Fusible Switch Type Metal Enclosed Switchgear.
 - c. Refer to Section 26 13 19 for 15kV Class Pad-Mounted Switchgear.
 - d. Refer to Section 26 24 13 for Switchboards - 600 Volt and Below.
 3. Coordinate submittal for grounding system with telecommunications grounding system, as indicated on telecommunications Drawings. Refer to Division 27 telecommunications systems grounding system and grounding requirements.
- D. Approvals: Secure formal approval of shop drawings and product data prior to ordering material. Secure approvals in sufficient time to allow installation of concealed system components without delaying the project.
- E. As-Built Record Drawings. The Contractor shall maintain a master set of As Built record drawings that shows changes and deviations from the Drawings, in accordance with Division 01 requirements and Section 26 00 00. Deliver As-Built record drawings to Owner upon Owner acceptance of project. Where not specified otherwise in Division 01 or the General and Supplementary Conditions of the construction contract, deliver one set of As-Built record drawings plotted to full-scale. Also deliver one set of As-Built record drawings in electronic format acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).

PART 2 PRODUCTS

2.01 GROUND RODS

- A. Materials. Provide 3/4-inch by 10-foot long, copper-clad, steel grounding electrodes. Supply a rod to which the copper cladding is permanently and inseparably bonded to a high strength steel core.
- B. Listing. UL 467.

2.02 CONNECTIONS

- A. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. For above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.
- B. Listing. UL 467.

2.03 CONDUCTORS

- A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity \geq 98 percent IACS conductivity.
1. Use solid conductor for No. 12 and No. 10 AWG.
 2. Use stranded conductor for No. 8 AWG and larger.
 3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.
 4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.
- B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.

- C. Location and Application.
 - 1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
 - 2. Outside building or structure. Use bare copper grounding conductors, including below-grade building grounding ring (counterpoise).
 - 3. Bonding jumpers. Use bare copper conductor.
- D. Listing. UL 83.

2.04 GROUND BUS

- A. Provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with ≥ 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required; where ground bus-bar of larger dimensions is indicated on plans or specifications provide the bus-bar with the larger dimensions. See E 2.4B for chemical ground rod measurements in test well.

2.05 GROUND TEST WELL/ROD

- A. General
 - 1. Self-contained XIT Grounding System(s) using electrolytic action to enhance the grounding performance shall be provided where specifically indicated on the drawings.
 - 2. The ground rod shall operate by hygroscopically extracting moisture from the air to activate the electrolytic process improving performance.
 - 3. Ground rod system shall be U.L. listed and manufactured for ten years or more.
 - 4. Ground rod system shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.
- B. Electrode Unit
 - 1. All copper XIT ground rod shall consist of a 2" nominal diameter hollow copper tube with a nominal wall thickness of .083". The tube shall be permanently capped on the top and bottom. Air breather holes shall be provided at the top and drainage holes shall be provided at the bottom of the tube for electrolyte drainage into the surrounding backfill material (Lynconite II or Lyncole Grounding Gravel).
 - 2. The XIT rod shall be filled from the factory with non-hazardous Calsolyte salts to enhance grounding performance.
 - 3. The XIT ground rod shall be a minimum of ten feet long for straight (vertical) installation.
 - 4. A stranded 4/0 AWG copper ground (or as specified) wire shall be exothermically welded to the side of the rod, near the top, for the electrode to grounding conductor connection.
- C. Protective Cover Box
 - 1. Fibrelyte composite box for light duty traffic applications. Includes bolt down flush cover with "breather" holes, XIT model XB-12F.
- D. Backfill Material Lynconite II:
 - 1. Natural volcanic, non-corrosive form of Lynconite II clay grout backfill material free of polymer sealants. Quantity of 50 lb. bags varies with the length of the diameter of the hole.
 - 2. Shall absorb approximately 13 gallons of water per 50-lb bag for an optional 320% solids density at a mixed coverage 2.1 cu. Ft. per bag.
 - 3. Ph value 8-10 with maximum resistivity of 60 ohm-cm at 30% solids density.
- E. Lyncole Grounding Gravel:
 - 1. Natural volcanic, non-corrosive form of Lynconite clay grout pelletized backfill material free of polymer sealants, supplied in 50 lb. bags.

2. Lyncole Grounding Gravel is an alternate grounding backfill used where Lynconite II cannot be used due to site conditions, installation requirements, standing water or other situations requiring use of this alternate grounding backfill.

F. Lyncole XIT for chemical ground rod/well system.

2.06 MANUFACTURER

- A. Copperweld.
- B. Cadweld.
- C. Burndy.
- D. Harger.

PART 3 EXECUTION

3.01 GENERAL

- A. Install grounding system in accordance with the requirements of the National Electrical Code (NEC), Article 250, and other applicable codes and standards. Coordinate installation of grounding and lightning protection system components with structural and civil work and placement of building structural mat.
- B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Connection to ground busbars is permitted as an exception to the restriction against splices in grounding conductors. Grounding conductors shall be as short and straight as possible, and protected from mechanical damage.
- C. Connect grounding electrode conductors to metal water pipe using suitable ground clamp, where metal water pipe is available and accessible and not protected by an insulating anti-corrosion covering. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter. The grounding electrode conductor shall not be spliced.
- D. Install fusion welded (exothermic) grounding connectors where they are below grade, concealed, or inaccessible. Above grade at accessible locations, use copper or bronze lugs and clamps. Grounding and lightning protection system connections made in conjunction with placement of the building structural mat shall be exothermic ground connectors.
- E. Strap grounding clamps shall not be used. Connections requiring bolting shall be made up with Monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.
- F. Where grounding conductors are installed in raceway, provide Schedule 40 PVC conduit inside the footprint of the building, and Schedule 80 PVC conduit for exterior or other locations outside the footprint of the building. Where exposed inside the envelope of the building, install grounding conductors in metallic raceway unless specifically indicated on Drawings to omit raceway. Where grounding conductors are installed in metallic raceway, bond to each end of metallic raceway where grounding conductors enter or exit the metallic raceway system. Metallic raceway systems that would form electrically inductive chokes shall not be used.
- G. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

3.02 SYSTEM DESCRIPTION

- A. Ground the electrical service neutral at service entrance equipment. Provide a main bonding jumper between the neutral and ground bus of the 480-volt main switchgear. Provide a separate grounding electrode conductor in conduit with grounding bushings on both conduit ends from the switchgear to the master ground bus-bar (MGBB) at the main electrical room. Bond MGBB to cold water metallic service pipe in contact with at least 10 feet of earth, and connect to opposite points of the building grounding ring (i.e., counterpoise) system by two main grounding conductors.

- B. Provide ground bus-bar, wall-mounted on insulated supports at 8'-0" AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room. See paragraph 3.5A, this Section.
- C. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.30 and paragraph 3.3G, this Section.
- D. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.
- E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.03 SYSTEM GROUND

- A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250 and as indicated on Drawings. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.
- B. Size. Size the system grounding electrode conductors as indicated on plans.
- C. Install grounding electrodes around exterior perimeter of building, a minimum of 3 feet outside the foundation of the building or facility. Space grounding electrodes at a distance between electrodes of at least twice their driven depth. Bond together ground rods by building ground ring (counterpoise). Install grounding electrode conductor in undisturbed earth, a minimum of 2 feet below excavated depth of building structural mat, crawlspace, or sub-grade.
- D. Depth: Bury grounding electrode conductors below grade to comply with NEC 250.50 and 250.52. Minimum depth 30 inches unless noted otherwise.
- E. Provide grounding electrode conductor pigtails at each ground rod for connection to building structural steel. Place PVC sleeves through foundation at column locations. Provide minimum 12 feet of excess pigtail above the building foundation or structural mat, prior to placement of concrete. Coil pigtail conductors and support above finished level of mat or foundation during concrete pour to prevent excess pigtail from being embedded or cemented in concrete.
- F. Provide main grounding electrode conductor pigtails at two locations on opposite sides of building for connection to power system neutral. Size main grounding electrode conductors as indicated on Drawings, minimum 4/0 AWG green-insulated copper conductor with Class-B stranding where not otherwise indicated. Provide larger conductors where indicated on Drawings. Place PVC sleeves through foundation and structure. Provide a minimum of 12 feet of excess pigtail above the building foundation or structural mat, as finally installed. Coil and support main grounding electrode conductor pigtails above finished level of mat or foundation during concrete pour to prevent excess conductor from being embedded or cemented in concrete. Connect grounding electrode conductors to main ground bus-bar at main electrical room. Connect power system neutral to main ground bus-bar at main electrical room. Provide test well for main grounding electrode conductor at each connection to ground rod, with reversible compression-type clamp.
- G. Separately Derived Systems. Ground neutrals of separately derived systems such as generators and transformers in accordance with NEC 250.30 and as indicated on Drawings.
 - 1. For each separately derived system, ground the neutral to system ground via the nearest ground busbar specifically provided for the purpose of grounding power distribution systems. Use unspliced grounding conductor from the neutral of the separately derived system to the ground busbar.
 - 2. Grounding conductors shall be as short and straight as possible, protected from mechanical damage, without splice or joint except as permitted by NEC 250.30 and paragraphs 3.1B and 3.3G.1 of this Section, above.

3. Transformers: Bond the center point (neutral or X0 terminal) of each wye-connected transformer to system ground at one point only. This point shall be ahead of the first overcurrent protective device (OCPD) connected to the secondary winding of the transformer. Refer to the applicable transformer specification for additional requirements.

3.04 SUPPLEMENTAL GROUND

- A. Supplementary Grounding Electrode: Where indicated on Drawings, provide supplementary grounding electrodes (ground rods) and bond to equipment grounding conductors per NEC-250.54 and NEC-250.118. Where larger bonding jumpers and/or conductors are indicated on Drawings, provide the size shown.

3.05 EQUIPMENT GROUND

- A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.
 1. Mount busbar 8 feet above finished floor and a minimum of 1 inch from wall.
 2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.
 3. Connect to the ground bus noncurrent-carrying metallic parts of electrical equipment and enclosures in the room.
 4. Bond grounding conductors to the bus as further indicated on Drawings.
 5. Provide #4/0 AWG copper conductor group loop around interior perimeter of electrical room at 8'-0" above finished floor level. Bond to each end of ground bus-bar by exothermic weld (i.e. cadweld). Make equipment grounding connection to copper loop by exothermic weld, where direct connection to ground bus-bar is not feasible.
- B. Raceway Systems and Equipment Enclosures.
 1. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.
 2. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.
 3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.
 4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing.
 5. Provide internal grounding conductor on liquid tight flexible metal conduit ("sealtite") with ground bushings.
 6. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.
- C. Size. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC Table 250.122. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.
- D. Taps, Splices and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.
- E. Underground Duct Bank: Provide bare copper grounding conductor embedded in concrete of underground duct bank for communications, utility and power systems. Bond conductor to ground lug or ground bus at each end of duct bank.

3.06 LIGHTNING PROTECTION SYSTEM

- A. Bond together lightning protection system ground rods to building ground ring (i.e., counterpoise). Provide bonding conductors for lightning protection ground rods separate from power system grounding electrode conductors.
- B. Bond together the lightning protection system ground rods and the power system grounding electrodes (i.e., ground rods) by connecting ground rods to the building ground ring (i.e., counterpoise). Make bonds at ground rods.
- C. Refer to Section 26 41 00, Lightning Protection System.

3.07 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.
 - 1. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.
 - 2. Resistance shall not exceed 5 ohm.
 - 3. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.
 - 4. Where measured resistance to ground exceeds 5 ohm, add additional ground rods to grounding system to achieve system resistance to ground of 5 ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 5 ohm or less, at no additional cost to Owner.
- C. Refer to Sections 26 05 19 and 26 27 30 for testing of isolated power systems per NFPA 99.
- D. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner's Representative.

3.08 CONFLICTS

- A. In the event a conflict exists between this specification and the referenced standards, the requirements of this specification shall be regarded as secondary and the necessary variances made in order to obtain a UL Master label for the lightning protection system.

END OF SECTION

**SECTION 26 0529
METAL FRAMING AND SUPPORTS**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of metal framing, including channels, fittings, clamps, hardware, electrical accessories and brackets.

1.02 SUBMITTALS

- A. None required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Make channels, fittings, clamps, electrical accessories and brackets of sheet steel or of malleable cast iron. Fabricate threaded fasteners of carbon steel.

2.02 COATINGS

- A. Hot-dip galvanize all steel components utilized indoors. Provide stainless steel framing for outdoor applications.

2.03 SIZES

- A. Provide channels fabricated from not less than 12-gage sheet steel, 1-5/8 inches wide and not less than 1-5/8 inches deep.

PART 3 EXECUTION

3.01 APPLICATION

- A. Hot-dip galvanized steel shall be used in all areas except use stainless steel components when exposed to the weather, in the crawl space and when located in a corrosive atmosphere.

3.02 SUPPORTS

- A. Provide metal framing to support large or heavy wall-mounted equipment, wall-mounted raceways and ceiling-hung raceways. Use stainless steel channel to mount the exhaust fan disconnect switches on the roof. Supports shall be mounted independent of the fan enclosure. Secure support to roof.
- B. Brackets with concentric holes, similar to Atkore trapeze supports, are not acceptable for conduit supports.

3.03 ANCHOR BOLTS

- A. Use 1/2 inch diameter by 3 inches long expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.04 TOUCH-UP

- A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent based zinc paint.

END OF SECTION

SECTION 26 0533 RACEWAYS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of electrical raceway systems.

1.02 REFERENCE STANDARDS

- A. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
- B. ANSI/ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.
- C. ANSI/UL 1 - Flexible Metal Conduit.
- D. ANSI/UL 5 - Surface Metal Raceways and Fittings.
- E. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
- F. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
- G. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
- H. ANSI/UL 797 - Electrical Metallic Tubing.
- I. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
- J. NEMA VE 1 - Metallic Cable Tray Systems.
- K. UL 6 - Rigid Metal Conduit.

1.03 SUBMITTALS

- A. Surface metal raceways and fittings.
- B. Provide product data on cable tray and fittings.

PART 2 PRODUCTS

2.01 CONDUIT AND FITTINGS

- A. Rigid Metal Conduit.
 - 1. Conduit. Rigid hot-dipped galvanized steel (RGS) conduit with zinc-coated threads and an outer coating of zinc chromate.
 - 2. Fittings. Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.
- B. Electrical Metallic Tubing (EMT).
 - 1. Conduit. Galvanized electrical steel tubing.
 - 2. Fittings. Steel compression type or steel set screw fittings, either cadmium plated or hot-dipped galvanized. Connectors shall have insulated throat bushings.
- C. Rigid Nonmetallic Conduit.
 - 1. Conduit. Schedule 40 polyvinyl chloride (PVC).
 - 2. Fittings. Solvent weld socket type.
- D. Flexible Metal Conduit.
 - 1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip.
 - 2. Fittings. One-screw and two-screw for 1-1/2 inches and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.
- E. Liquid-tight Flexible Steel Conduit.
 - 1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
 - 2. Fittings. Compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.
- F. Elbows.
 - 1. Provide large radius elbows.

2.02 WIREWAYS

- A. Material. Not less than 16-gage sheet steel.
- B. Dimensions. Cross section dimensions no less than 4 inches by 4 inches.
- C. Finish. Not less than two coats of enamel over a rust-inhibiting prime coat.
- D. Type.
 - 1. Indoors. NEMA 1.
 - 2. Outdoors. NEMA 4X.

2.03 SURFACE RACEWAYS AND FITTINGS

- A. Provide two compartment aluminum raceway for locations requiring both power and data. Provide Hubbell HBLALU5000 series or approved equal.
- B. Provide single compartment aluminum raceway for locations requiring power only power. Provide Hubbell HBLALU2000 series or approved equal.

2.04 CABLE TRAY AND FITTINGS

- A. Cable tray shall be 18" wide by 6" deep, B-Line series WB618 or equal.
- B. Tray: NEMA VE 1/CSA E22.2 No. 126.1.
- C. Material and Finish of Tray, Fittings, and Accessories: Electroplated yellow zinc dichromate per ASTM B633 SC2.
- D. Inside radii of fittings: as indicated on Telecom Drawings
 - 1. Accessories and Fittings: Manufacturer's standard clamps, tees, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- E. Warning signs for cable trays:
 - 1. 1/2-inch high black letters on yellow plastic with the following wording: "WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!"

PART 3 EXECUTION

3.01 CONDUIT AND FITTINGS

- A. Minimum Trade Size. 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures.
- B. Types According to Use.
 - 1. Use hot dipped galvanized rigid steel conduit (RGS) outside above ground where exposed to weather.
 - 2. Use EMT in interior walls or ceiling spaces and where exposed in open work areas, mechanical rooms or electrical rooms. Conduit that enters or leaves the top of panelboards or enclosures may be EMT, provided such panelboards and enclosures are located in mechanical or electrical rooms.
 - 3. Conduits may not be embedded in slabs without approval of the owner and the structural engineer.
 - 4. Use rigid nonmetallic conduit (Type DB) encased in concrete with minimum 3-inch-thick walls, where installed below grade. Concrete encasement may be omitted when conduit is used for site lighting circuits. In these cases use Schedule 40 PVC. All horizontal to vertical transitions shall be made using RGS elbows RGS conduit stub-ups. Seal all conduits weather tight.
 - 5. Connect all indoor electrical equipment subject to vibration or movement with flexible metal conduit 24 inches minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 4 feet and the conduit shall be flexible metal conduit. Where the equipment is located outdoors or exposed to water, liquid-tight flexible metal conduit shall be used.
 - 6. Transitions.

- a. Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.
 - b. For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 4 inches above finished grade and slope top away from conduit with a 6-inch-per-foot slope.
 - c. For below-grade to above-grade locations using PVC to metal conduit, make the transition from PVC to metal conduit before turning up with RGS elbow.
- C. Preparation. Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins. In addition. Seal the interior of all conduit openings for moisture where conduits penetrate and exterior wall or floor.
- D. Installation Requirements.
1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For EMT terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where feeder conduits, 1-1/2 inches and larger, terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
 2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
 3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.
- E. Installation Methods.
1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
 2. Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent based zinc paint. When dry, draw up tight.
 3. Make bends with minimum radius per NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.
 4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.
 5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits. Branch circuit raceways which are 1 inch or smaller may be attached to wall studs by use of manufactured clips. Brackets with concentric holes, similar to Atkore trapeze supports, are not acceptable.
 6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading "Pulling Line - Telephone," etc.
 7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.

8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
9. Use expansion fittings in conduit that terminates at sensitive equipment.
10. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.
11. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

3.02 WIREWAYS

- A. Install wireways, where shown, according to NEC Article 376. Field apply a 90 percent zinc paint coating over cuts or scratches before any other finish is applied.

3.03 SURFACE RACEWAYS

- A. Install surface raceways, where shown, according to NEC Article 300. Securely ground raceway and fittings. Provide bushings at raceway entrances. Raceways shall be two compartment, top for receptacles and bottom for data. Provide power conduit and wiring as shown on plans. Provide 1-1 1/4" conduit from data compartment to cable tray. Conduit shall terminate in a flush mounted box at surface raceway location. Provide a 2" nipple between the box and the back of the surface raceway.
- B. Where surface metal raceway is shown in a corner, provide a continuous section of raceway for a clean installation.

3.04 CABLE TRAY

- A. Install in conformance with NEC and NEMA requirements and in accordance with manufacturer's instructions. Arrange cable tray to maintain headroom and present neat appearance. Cables shall be arranged in cable trays in a neat, workmanlike manner.
- B. All cable tray cuts/modifications shall be done with manufacturer approved cutters.
- C. Support cable tray a minimum of every 5' on center with manufacturer provided trapeze support kit. Kit shall be a B-Line Model WB5518 for use with 3/8" all thread rod. Provide all accessories necessary for a complete installation. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 5 feet maximum. Trays shall be level.
- D. Contractor shall utilize manufacturer's standard components. Where standard components are not available, modifications shall be per manufacturers instructions/specifications.
- E. Provide a continuous solid barrier that is electrically continuous installed in all sections of the cable tray. The purpose of the barrier is to separate AV cables from telecom cables. Place the barrier such that 1/4 of the tray will be for AC cabling and 3/4 of the tray will be for telecom cables.
- F. Where it is necessary to make field changes in the tray system, all changes shall be made per manufacturers recommendations.
- G. Maintain twelve-inch clearance between cable tray and surfaces with temperatures exceeding 104 degrees F, such as flues, steam pipes, and heating appliances. Maintain at least 4-inch clearance between cable tray and piping, ductwork or other interference. Any deviation from this must be approved by the Owner. It shall be the Contractor's responsibility to protect existing cable tray in the area of construction against damage throughout the construction period. Any damaged cable tray shall be replaced by the Contractor at no additional cost prior to final acceptance by the Owner.
- H. All communication cable trays shall have a continuous, No. 6, green insulated copper grounding conductor run inside the tray. Connect to tray at each fitting or tray section. Connect the tray at each end to the ground bar in the telecom room with #4 AWG. All bonds shall be via exothermic weld. The direction of the welded bond shall be oriented in the correct direction along bonding backbone.

- I. Maintain electrical continuity between sections of cable tray using manufacturer provided splice plates and bond cable trays at the both ends to building ground plates to provide a continuous grounding path. Install copper braided bonding jumpers around expansion joints and hinged adjustable splice plates where electrical discontinuity occurs. Install cable trays, where shown, according to NEC Article 392. Install cable trays in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 26 0537 BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of outlet boxes, floor boxes, junction boxes and pull boxes.

1.02 REFERENCE STANDARDS

- A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
- B. ANSI/UL 514A - Metallic Outlet Boxes.
- C. ANSI/UL 514B - Fittings for Conduit and Outlet Boxes.

1.03 SUBMITTALS

- A. Provide product data.

PART 2 PRODUCTS

2.01 OUTLET BOXES

- A. Flush Device Boxes. Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device(s) to be installed. Square or rectangular boxes may be used. Unless otherwise noted, provide minimum 2-1/8-inch deep by 4-inch square minimum size box. For data outlets provide minimum 2-1/8-inch deep by 4-11/16 inch square minimum size box.
- B. Exposed or flush Device Boxes. Provide FS or FD cast boxes for surface mounting in areas having exposed rigid metal conduit systems.
- C. Boxes for Lighting Fixtures. Provide galvanized steel octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 2-1/8-inch deep by 4-inch box.
- D. Masonry Boxes. Provide galvanized steel, 3-1/2-inch deep, masonry boxes for all devices installed in masonry walls.
- E. Switch Boxes. Not permitted.
- F. Listing. UL 514.

2.02 FLOOR BOXES

- A. Box. See AV plans.
- B. Cover. See AV plans.
- C. Location. Specific floor box locations are indicated on the electrical and AV plans.

2.03 JUNCTION, PULL AND SPLICE BOXES

- A. Construction. Provide galvanized steel boxes conforming to NEC Article 314.
- B. Interior Spaces. Provide NEMA 1 type boxes at least 4 inches deep.
- C. Exterior Spaces. Provide NEMA 4X type boxes at least 4 inches deep.
- D. Embedded. Provide NEMA 4 cast iron type with flush flanged cover when cast in concrete.
- E. Listing. UL 514.

PART 3 EXECUTION

3.01 OUTLET BOXES

- A. Flush Boxes. Unless otherwise indicated, mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes. Provide plaster covers for all boxes in plastered walls and ceilings.
- B. Fixture Boxes. Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.
- C. Mounting Height. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. Verify the final location of each outlet with Owner's representative before rough-in. Remove and relocate any outlet box placed in an unsuitable location.
- D. Back-to-Back Boxes. Do not connect outlet boxes back-to-back unless approval is obtained from the Owner's representative. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.
- E. Box Openings. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.02 FLOOR BOXES

- A. Verify locations of all floor boxes with the Owner's representative before installation. Completely envelope floor boxes in concrete except at the top. Increase slab thickness at boxes if required to obtain a minimum of 2 inches of concrete below bottom of box. Adjust covers flush with finished floor.

3.03 JUNCTION AND PULL BOXES

- A. Installation. Install boxes as required to facilitate cable installation in raceway systems. Provide a junction box for terminating of flexible metal conduit to light fixtures. In general, provide boxes in conduit runs of more than 100 feet.
- B. Covers. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.
- C. Colors. Provide boxes with the following covers: Fire Alarm – Red, Emergency – Pink, Security – Purple, Control – Green, Data/Telecom – Orange, 480/277V normal power – Yellow, 208/120V normal power - Blue.

END OF SECTION

**SECTION 26 0553
ELECTRICAL IDENTIFICATION**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Nameplates and tape labels.
- B. Wire and cable markers.
- C. Conduit color coding and labeling.

1.02 REFERENCES

- A. NFPA 70 – National Electrical Code (NEC).

1.03 SUBMITTALS

- A. Provide submittals in accordance with and in additional to Section 26 00 00, Electrical General Provisions, and Division 01, for submittal requirements.
 - 1. Furnish nameplate identification schedules to Owner's Representative for review and acceptance, listing equipment type and nameplate data with letter sizes and nameplate material.
 - 2. Nameplate Schedules. Prior to fabrication of nameplates, furnish to Owner for review and acceptance a schedule of nameplates for electrical equipment. For each equipment and circuit identified, provide 4-line nameplate as follows:
 - a. Line 1: Device designation, switchgear or MCC cubicle, switchboard circuit, etc. as indicated on plans, schematics, or schedule Drawings.
 - b. Line 2: Leave blank for Owner's use.
 - c. Line 3: Source or voltage characteristics, as applicable.
 - d. Line 4: Load served.
 - 3. Refer to Parts 2 and 3 of this Section for nameplate requirements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Equipment Nameplates:
 - 1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
 - 2. For emergency equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
 - 3. For UPS powered equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
 - 4. For fire alarm system, provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
 - 5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.
 - 6. Nameplate minimum size shall be 1 inch high by 3 inches long with engraved white letters. Generally, the number and name shall be at least 1/4 inch high and other data at least 1/8 inch high.
- B. Underground Warning Tape:
 - 1. Manufactured polyethylene material and unaffected by acids and alkalines.
 - 2. 3.5 mils thick and 6 inches wide.
 - 3. Tensile strength of 1,750 psi lengthwise.
 - 4. Printing on tape shall include an identification note "BURIED ELECTRIC LINE", and a caution note "CAUTION". Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.
 - 5. Detector Strip. Metallic tape or similar detector strip, integral to warning tape.

- C. Conductor Color Tape and Heat Shrink:
 - 1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
 - 2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of conductor or cables are not acceptable.
- D. Conduit Labels (15 kV Conduits Only): 2-inch black letters on yellow background reading "DANGER - 13,200 VOLTS". Labels shall have adhesive backing, and shall be installed at intervals not exceeding 50 feet and on pull boxes located to be visible from floor.
- E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2 inch lettering.
- F. Tape Labels: Provide device labels of plastic adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
 - 1. Normal power. Black letters on clear background. Provide white letters on black background where specifically indicated on Drawings or specified in other Sections.
 - 2. Emergency/standby power. Red letters on clear background. Provide white letters on red background where specifically indicated on Drawings or specified in other Sections.
 - 3. UPS power. Orange letters on clear background. Provide white letters on orange background where specifically indicated on Drawings or specified in other Sections.
 - 4. Provide device label with black letters, one half inch wide tape with one quarter inch high letters, minimum.
 - 5. Manufacturer. Brother type "P-Touch", or accepted substitution.
- G. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4 inch high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

PART 3 EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in individually wrapped factory-fabricated fiberboard-type containers.
- B. Store materials in a clean and dry space, elevated above grade, and protected from weather and sunlight.
- C. Handle materials carefully to avoid damage, breaking, denting and storing. Damaged materials shall be rejected and shall not be installed.

3.02 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates or tape labels.
- B. Install nameplates parallel to equipment lines.
- C. Secure plastic nameplates to equipment fronts using stainless steel self-tapping screws or rivets. Use of adhesives shall be per Owner's approval. Stick-on or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.
- D. Designations: Externally mark equipment, feeders, branch circuits and similar items with nameplates with the same designations as indicated on the Drawings.

3.03 WIRE AND CONDUCTOR IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, ground busbars and at load connection.
 - 1. Identify with branch circuit or feeder number for power and lighting circuits.
 - 2. Label control conductor with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

3. Label grounding conductors at ground busbars, electrical equipment, and test wells with metal tags indicating the cable purpose and point of termination at opposite end of cable. Securely fasten metal tags along the length of the grounding cable or conductor. Place metal tags to avoid creating short circuits, inadvertent grounding paths, or other contact with grounded or energized terminals, conductors, or components.
- B. Existing Facilities. Where the Contractor encounters conductor identification in existing electrical distribution systems different from the colors scheduled in this Section, notify the Owner's Representative in writing and propose a resolution, in accordance with the requirements of Part 1 of Section 26 00 00, Electrical General Provisions.
- C. Conductors for power and lighting circuits shall be identified per the following schedule.

Conductor	480/277V	208/120V	Medium Voltage
Phase A	Brown	Black	One White Band
Phase B	Purple	Red	Two White Bands
Phase C	Yellow	Blue	Three White Bands
Neutral	Gray	White	N/A
Grounding	Green	Green	Green
Isolated Ground (IG)	N/A	Green w/Yellow Tracing Stripe	N/A

- D. Where more than one conductor of the same phase or more than one neutral or ground conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. The neutral tracer color shall match the phase conductor color with which it is associated.
- E. Switch leg conductors. Pink.
 1. The color of switch leg conductors shall be pink, marked with tape matching the color of the associated branch circuit phase conductors.
- F. Low voltage wiring systems. Conductors for low voltage circuits shall be identified as follows.
 1. Fire Alarm. Red
 2. Security. Blue and Yellow. Coordinate wiring color with Division 27 and telecommunications supplier
 3. Clock. Green and White
 4. Telephone. White. Coordinate wiring color with Division 27 and telecommunications supplier
 5. Data. Bright Blue. Coordinate wiring color with Division 27 and telecommunications supplier.
 6. HVAC Controls. Dark Blue. Coordinate wiring color with Division 23 and controls supplier.

3.04 NAMEPLATES

- A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
 1. Externally mark electrical equipment with nameplates identifying each and the equipment served.
 2. Supply blank nameplates for spare units and spaces.
- B. Nameplate Fasteners. Fasten nameplates to the front of equipment by means of stainless steel self-taping screws. Stick-on or adhesives are not allowed unless the NEMA enclosure rating is compromised, then use only epoxy adhesive to attach nameplates.
- C. 15 KV-Class Switches.
 1. On main switches or circuit breakers: 3/8 inch: identify the equipment designation. 1/4 inch: identify system voltage and characteristics (i.e., 12.47 KV, 3PH, 3W).

2. For each switch or circuit: 3/8 inch; identify the circuit or cubicle. 1/4 inch: identify the load served.
- D. 480-volt Switchboard/switchgear:
 1. On the main switches or circuit breakers: 3/8 inch: identify the equipment designation. 1/4 inch: identify the source and voltage characteristics (i.e., 480/277V, 3PH, 4W).
 2. For each branch circuit protective device: 3/8 inch: identify the circuit or cubicle. 1/4 inch: identify the load served.
- E. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4 inch: identify source to device and the load it serves, including location.
- F. Dry Type Transformers Not in Substations: 3/8 inch: identify equipment designation. 1/4 inch: identify primary and secondary voltages, primary source, and secondary load and location.
- G. Panelboards: 3/8 inch: identify equipment designation. 1/4 inch: identify source, voltage and bus rating.
- H. Provide complete circuit directory for each new panel board. Provide complete circuit directory for each existing panelboard with circuits added, removed, demolished, moved, renovated, or otherwise altered as part of this project or as work required by or incidental to this project. Refer to Section 26 24 16 for directory requirements.
- I. Identification tags on items in finished areas, such as special switches, etc., shall be securely attached on, or in the immediate vicinity, of the item. Supply blank nameplates for spare units and spaces.

3.05 ENCLOSURE COLOR CODING

- A. The following systems shall have each enclosure and cover completely painted as follows:
 1. Fire Alarm. Red, with black "FA" text.
 2. Emergency Power. Red, with black "E" text.
- B. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Ethernet Backbone	Blue
Telecommunications	Brown
FCMS	Green
Emergency Power	Red, with black "E" text
Security**	White
Fire Alarm	Red, with black "FA" text
Clock	Fluorescent Violet

**Security shall include, but not be limited to, the following systems:

- Card Access
- Duress Alarms
- Perimeter Door Alarms

- C. CCTV

3.06 EQUIPMENT AND DEVICE MARKING

- A. Pull, Junction and Outlet Boxes.
 - 1. With 1/2-inch high permanent lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Identify complete circuit numbers on box cover and on the conduit.
 - 2. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation. Identify both phase and associated neutral conductors.
 - 3. Boxes and covers containing emergency power or emergency lighting circuits shall be painted red. Factory finish is acceptable in lieu of painting in the field. No other raceway, conduit, boxes, or enclosures shall be painted red.
 - 4. Fire alarm boxes and covers shall be painted red. Using permanent lettering, identify box cover as "F/A" or "FAS", with fire alarm zone served. Factory finish is acceptable in lieu of painting in the field. No other raceway, conduit, boxes, or enclosures shall be painted red.
- B. Equipment and Raceways Over 600 Volts: Provide "WARNING - HIGH VOLTAGE - KEEP OUT" signs on equipment. With 2-inch-high lettering, mark exposed raceways containing conductors operating in excess of 600 volts every 50 feet, or in each room or space or compartment of penetration, and at each wall or floor penetration, with the words "WARNING - HIGH VOLTAGE -13,200 VOLTS".
- C. Power Receptacles: Use a clear plastic tape label, nameplate or engraved device plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate. Nominal 120 volt power receptacles shall be labeled with the complete circuit number.
- D. Snap Switches:
 - 1. Where the equipment served is not in sight of the snap switch, or where snap switch controls dedicated outlets or special equipment, provide a clear plastic tape label or an engraved switch plate to identify equipment served.
 - 2. Where snap switches are grouped together, provide clear plastic tape labels or engraved switch plates to identify non-lighting equipment served.
- E. Dedicated Outlets: For dedicated outlets, provide a clear plastic tape label or an engraved coverplate indicating the equipment served. Dedicated is understood to be specific equipment listed by equipment number in the panel schedules or identified on the plans. Dedicated also includes computer outlets.
- F. Remote Ballasts: For remote ballasts not within five feet of their luminaire, provide appropriate permanent lettering on both the ballasts and the luminaire to identify which units are mated to the other.

END OF SECTION

SECTION 26 0573
SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH RISK ASSESSMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Provide a complete short-circuit and protective device coordination study for the normal and emergency/standby power electrical distribution systems. The extent of the study shall be from distribution panel HVP-ZA. The study shall be completed by the manufacturer of the 480V switchboard/switchgear.
- B. The contractor shall furnish an Arc Flash Risk Assessment per the requirements set forth in the latest edition of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash risk assessment shall be performed according to the IEEE 2018, 1584 equations that are presented in the latest edition of NFPA 70E. The arc flash risk assessment shall encompass all normal and emergency/standby power electrical distribution systems.

1.02 SUBMITTALS

- A. A preliminary short-circuit study shall be submitted to the design engineer either before or at the same time as the equipment submittals. If equipment submittals such as switchgear, switchboards, panelboards etc. are submitted without a preliminary study, they will be returned Rejected.
- B. The results of the short-circuit, protective device coordination and arc flash risk assessment studies shall be summarized in a final report. The report shall include the following sections:
 - 1. Executive Summary.
 - 2. Descriptions, purpose, basis and scope of the study.
 - 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
 - 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
 - 5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - 6. Details of the incident energy and flash protection boundary calculations.
 - 7. Recommendations for system improvements, where needed.
 - 8. One-line diagram.
- C. Arc flash labels shall be provided for all equipment described in section 3.02.

1.03 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- C. The National Fire Protection Association (NFPA)
 1. NFPA 70 - National Electrical Code, latest edition.
 2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.04 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash risk assessment studies shall be conducted by the manufacturer of the 480V distribution equipment and under the supervision and approval of a Licensed Professional Electrical Engineer, licensed in the state of Texas and skilled in performing and interpreting the power system studies.
- B. The Licensed Electrical Engineer shall be a full-time employee of the equipment manufacturer and have a minimum of five (5) years of experience in performing power system studies.

1.05 COMPUTER ANALYSIS SOFTWARE

- A. The studies shall be performed using the latest revision of ETAP or SKM Systems Analysis Version 11 or higher.

PART 2 PRODUCTS

2.01 DATA COLLECTION

- A. The Contractor shall be responsible for collecting all data for the studies.

2.02 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Provide the following:
 1. Calculation methods and assumptions.
 2. Selected base per unit quantities.
 3. One-line diagram of the system being evaluated.
 4. Source impedance data, including electric utility system and motor fault contribution characteristics and X/R ratios.
 5. Tabulations of calculated quantities.
 6. Results, conclusions, and recommendations.
 7. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a line to ground fault at each piece of equipment/bus.
- B. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short circuit ratings.
 2. Adequacy of all equipment to withstand short-circuit stresses.
- C. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- D. Transformer design impedances shall be used only when test impedances are not available.

2.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. The phase curves shall be plotted on separate sheets from the ground fault curves.
- B. Plot the following characteristics on the TCC graphs where applicable:
 1. Equipment name based on Bid documents.
 2. Electric utility's overcurrent protective device.
 3. Medium voltage (4.16kV) equipment overcurrent relay settings.
 4. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

5. Low voltage (480V and below) equipment circuit breaker trip device settings, including manufacturer's tolerance bands.
 6. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 7. Ground fault protective devices, as applicable.
 8. Pertinent motor starting characteristics and motor damage points, where applicable.
 9. Pertinent generator short-circuit decrement curve and generator damage point.
- C. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.04 ARC FLASH RISK ASSESSMENT

- A. The Arc-Flash Risk Assessment shall be performed according to the IEEE 1584-2002 equations that are presented in the latest edition of NFPA 70E, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway, ATS's and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Risk Assessment shall include all electrical equipment.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. The results of the short circuit calculations (fault values) and protective device coordination study (device clearing times) shall be utilized for use by the arc flash program. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.05 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:
1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
 3. Reactor data, including voltage rating, and impedance.
 4. Generation contribution data, (synchronous generators and Utility), including short-circuit sub-transient reactance (X''_d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage.
 - b. Calculated fault current magnitude and angle.
 - c. Fault point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage.
 - b. Calculated symmetrical fault current magnitude and angle.
 - c. Fault point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 - e. Equivalent impedance.
 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage.
 - b. Calculated symmetrical fault current magnitude and angle.
 - c. Fault point X/R ratio.
 - d. No AC Decrement (NACD) Ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.
- C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.

- e. Recommendations on improved relaying systems, if applicable.
- 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc flash boundary.
 - 5. Working distance.
 - 6. Incident energy.
 - 7. Recommendations for arc flash energy reduction.

PART 3 EXECUTION

3.01 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Provide programming for all relays including trip and logic equations. The relay shall be fully functional before any equipment is energized.

3.02 ARC FLASH WARNING LABELS

- A. The contractor performing the Arc Flash Risk Assessment shall provide a 4 in. x 4 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Flash protection boundary.
 - 4. Incident energy.
 - 5. Working distance.
 - 6. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. See page 7 for example of arc flash label.
 - 1. For each 480V and 208V panelboard, one arc flash label shall be provided.
 - 2. For each motor control center, one arc flash label shall be provided at the front and rear of each section (where applicable).
 - 3. For each low voltage switchboard, one arc flash label shall be provided for each section.
 - 4. For each low and medium voltage switchgear, one arc flash label shall be provided for each breaker and one arc flash label shall be provided at the rear of the gear for each section.
 - 5. For automatic transfer switches (ATS) and medium voltage switches, one arc flash label shall be provided at the front and rear of the switch (where applicable).

6. Two arc flash labels shall be provided for each bus riser on every floor in the facility (where applicable).
 7. One arc flash label shall be provided for each disconnect switch, and motor starter.
- F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

- A. The contractor performing the Arc Flash Risk Assessment shall train the owner's qualified electrical personnel of the potential arc flash risks associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.



DANGER

Arc Flash and Shock Risk Appropriate PPE Required

Flash Protection:		
18 in	Flash Hazard	Level 4 PPE/Clothing
14 cal/cm ²	Minimum Arc Rating	
81 in	Flash Protection Boundary	
Level 4	Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit	
Shock Protection:		
480 VAC	Shock Hazard	Glove Class 00
42 in	Limited Approach	
12 in	Restricted Approach	

PROT: BPNH-RIS#2 Fdr
EQPT: BUS PLUG TO XFMR G12NHC
03/27/2017
Failure to Comply Can Result in Death or Injury!

END OF SECTION

SECTION 26 2214
HIGH EFFICIENCY K-7 TRANSFORMERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Fabricate and test low voltage dry-type distribution transformers as described in this specification and on the Drawings.

1.02 SUMMARY

- A. Transformers meeting US Department of Energy 2016 mandated minimum efficiency. These transformers shall be UL listed to feed a K-7 electronic equipment load profile and be optimized to minimize operating cost under light loading.
- B. Compliance with full specification is required.
- C. Transformers shall meet the following requirements:
 - 1. Efficiencies must meet or exceed the US DOE 2016 minimum requirement.
 - 2. No load losses must comply with those defined in this specification.
 - 3. Efficiency at low load and under nonlinear load must meet the minimum requirements of this specification.
 - 4. K-4 or K-13 listing per UL 1561 is required, see plans.
 - 5. Comprehensive testing under linear and nonlinear loading is required to verify specified performance. Performance submittals are required.
- D. The Work under this Section is subject to requirements of the Contract Documents including the Uniform General Conditions, Supplementary General Conditions, and Division One Sections.
- E. All work covered by this Section shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.
- F. Drawings and general provisions of the Contract, including Terms and Conditions, Supplementary Conditions, Special Conditions, and other Division One Sections, apply to this Section.

1.03 REFERENCES

- A. US Department of Energy, 10 CFR Part 431, April 18, 2013. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule
- B. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.
- C. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.
- D. NEMA Premium Efficiency Transformers Program
- E. Consortium for Energy Efficiency (CEE): Specification for Low-Voltage, Dry- Type Distribution Transformers
- F. EPACT 2005 - United States Energy Policy Act 2005 / NEMA TP1 - Guide for Determining Energy Efficiency for Distribution Transformers
- G. ANSI/NEMA TP-2 – Standard Test Method for Measuring Energy Consumption of Distribution Transformers
- H. IEEE C57.110-1998 – IEEE Recommended Practice for establishing transformer capability when feeding nonsinusoidal load currents.
- I. IEEE Std C57.12.91-1995 Standard Test Code for Dry-Type Transformers
- J. IEEE-1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

- K. LEED – Leadership in Energy and Environmental Design, U.S. Green Building Council.
- L. ISO 9001:2008 – International Standards Organization - Quality Management System
- M. ISO 14001:2004 – International Standards Organization - Environmental Management System
- N. ISO 17025 – International Standards Organization - General requirements for the competence of testing and calibration laboratories

1.04 RELATED SECTIONS

- A. Section 26 0526, Grounding and Bonding.
- B. Section 26 0533, Raceways.
- C. Section 26 0529, Metal Framing and Supports.
- D. Section 26 0573, Overcurrent Protective Device Coordination Study.

1.05 SUBMITTALS

Submit product data including the following:

- A. Where one or more of the integrated transformer options is selected for this project, provide associated documentation.
- B. Construction details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, unit weight.
- C. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight.
- D. Documentation of UL listing of 2" clearance from ventilated surfaces.
- E. Inrush Current (typical 3 cycle recovery)
- F. Short Circuit Current data: Primary & Secondary
- G. Efficiency, Loss & Heat output Data
- H. No load and full load losses per NEMA ST20
- I. Linear load data @ 1/4, 1/2, 3/4 & full load
- J. Linear Load efficiency @ 35% loading tested per NEMA TP-2.
- K. 5 year Product Warranty Certificate.
- L. Manufacturer documentation that sizing primary protection at 125% of nominal full load amps will not result in nuisance tripping on transformer inrush.
- M. Efficiency under K7 load profile at 25%, 50%, 75%, 100% of nameplate rating.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store and protect products.
- B. Store in a warm, dry location with uniform temperature. Cover ventilation openings to keep out dust, water and other foreign material.
- C. Handle transformers using lifting eyes and/or brackets provided for that purpose. Protect against unfavorable external environment such as rain and snow, during handling.

1.07 WARRANTY

- A. In addition to the requirements of Division 01 and Section 26 0000, provide 5 year pro-rated warranty against defects in materials and workmanship, with limited liability.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/PRODUCT

- A. Square D, ABB/General Electric, Powersmiths International Corp.

2.02 RATINGS

- A. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.
- B. Copper or aluminum wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to UL1561, NEMA ST20 and other relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be UL Listed and CSA Approved. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.
- C. Insulation System:
 - 1. Shall be NOMEX-based impregnant for lowest environmental impact, long term reliability and long life expectancy.
 - 2. Class: 220 degrees C
 - 3. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
 - 4. Epoxy co-polymer
 - 5. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)
 - 6. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
 - 7. Chemical Resistance: Must have documented excellent performance rating by supplier
 - 8. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
 - 9. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life
- D. Operating Temperature Rise: 115 degree C in a 40 degree C maximum ambient
- E. UL Listed & Labeled K-Rating: K-7 or higher
- F. Enclosure type: Indoor Ventilated NEMA 1
- G. Rear Clearance: UL Listed for 2" clearance minimum from the wall rather than standard 6". This capability shall be explicitly described on the nameplate of each unit.
- H. Exceed minimum efficiency requirements of US Department of Energy, 10 CFR Part 431, April 18, 2013, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule which takes effect January 1, 2016, and comply with the table of Maximum No Load Losses, efficiency requirements at 1/6 load, efficiency at 35% load per 10 CFR Part 431, and efficiency at 35% load under a K-7 load profile. THIS NEEDS UPDATING. WAITING FOR INFO FROM OTHER MANUFACTURERS

kVA	No load losses (Watts)	Efficiency @ 1/6 load (%)	Efficiency @ 35% load (%)	Efficiency at 25% load under K-4, K13 nonlinear load
15	47	97.85%	98.28	98.00%
20	60	98.05%	98.34	98.10%
25	66	98.15%	98.41	98.15%
30	71	98.27%	98.50	98.30%
45	97	98.40%	98.66	98.40%
50	112	98.45%	98.67	98.42%
63	120	98.50%	98.75	98.48%
75	135	98.63%	98.82	98.60%
100	180	98.65%	98.88	98.65%
112.5	195	98.70%	98.92	98.70%
125	215	98.73%	98.94	98.72%
150	235	98.80%	98.99	98.80%

- I. Voltage Taps: For transformers 15kVA-150kVA, provide two 2-1/2% full capacity taps above and four 2-1/2% taps below nominal primary voltage.
- J. Impedance: Between 3.0% and 6.0% unless otherwise noted.
- K. Grounding: Ground the core of the transformer to the enclosure with a flexible grounding conductor sized according to NEC requirements.
- L. Lug Kit: supply with Compression lugs configured as specified at time of order

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Delivery. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- B. Storage. Store transformers in a clean, dry space, elevated above grade, and protected from weather, moisture, sunlight, and dirt. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Temporary Heating. Apply temporary heat for protection from insulation moisture absorption and metallic component corrosion in accordance with paragraph 3.2B of Section 26 0000, Basic Electrical Requirements, and according to manufacturer's written instructions. Apply temporary heat within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.
- D. Stacking. Do not stack transformers.
- E. Work Surface. Transformers shall not be used as work tables, scaffolds, platforms, or ladders.
- F. Handling. Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.
- G. General Provisions. Refer to Part 3 of Section 26 0000, Basic Electrical Requirements.

3.02 INSPECTION

- A. Installer shall examine the areas and conditions under which dry type transformers are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Install dry type transformers in locations indicated on Drawings, in accordance with the applicable requirements of the NEC, NEMA, and ANSI.
- B. Where sound level may be of concern, utilize the services of a recognized and established Acoustical Consultant to provide the proper installation environment to minimize noise and vibration
- C. Check for damage and tight connections prior to energizing transformer.
- D. Set transformers plumb and level.
- E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- F. Ventilation.
 - 1. Provide adequate clearance around transformer for ventilation of core, coil and internal components; minimum 1 foot – 0 inch front and sides unless noted otherwise and 4 inches to the back side from a wall.

2. Where transformers are proposed for installation vertically one above the other, provide sufficient vertical separation between transformers to permit adequate air circulation for proper cooling of each transformer, in accordance with manufacturer recommendations. Take temperature measurements of transformers under load and document temperature rise and temperature of each transformer where mounted in a vertical arrangement. Where the temperatures exceed manufacturer's recommendations or the requirements of this Section, relocate transformers to provide adequate cooling.
- G. Verify all dimensions in the field.
- H. Coordinate all work in this Section with that in other sections.
- I. Provide Seismic restraints where required
- J. Verify removal of coil shipping anchor bolts before transformer is energized.
- K. Adjust transformer secondary voltages to provide the required voltage at the loads.

3.04 FLOOR MOUNTING

- A. Provide concrete pad for floor-mounted transformers. Refer to structural Drawings and specifications for design criteria. Where not otherwise indicated, and in addition to the requirements of Section 26 0000, Electrical General Provisions, and Section 26 0529, Metal Framing and Supports, construct pads of nominal 4 inch thick 2500 pound concrete reinforced with 6 inch x 6 inch steel wire mesh. Size pads 3 inches wider than transformer and chamfer edges to a 3/4 inch bevel.
- B. Maintain a minimum of 12 inches free air space between enclosure and walls.
- C. Vibration isolation. Provide vibration and sound isolation system suitable for isolating the transformer noise from the building structure.
 1. Provide spring-type isolators in suspension system sized to support the transformer weight, one at each corner of transformer lower mounting rails. Manufacturer: Korfund/Aeroflex type LK, or accepted substitution.
 2. Use one pad type Korfund Elasto-Grip, waffle, or accepted substitution, at each corner of the transformer, below the spring-type isolators, sized for load of 50 lbs./sq.-in.
- D. Secure the transformer and vibration isolators to the pad as recommended by the manufacturer.
- E. Refer to Section 26 0529, Metal Framing and Supports.

3.05 CONDUIT CONNECTIONS

- A. Flexible Metallic Conduit. Attach incoming and outgoing conduits to the transformer enclosure with flexible metallic conduit (FMC), minimum length 24 inches.
 1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.
 2. Provide grounding-type coupling at each end of flexible metallic conduit. Provide a bonding jumper on outside of flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.
- B. Liquid Tight Flexible Metallic Conduit. Where indicated, use liquid-tight flexible conduit for connections to transformer case, maximum length 6 feet, minimum length 3 feet, with slack or dip to attenuate noise transmitted through conduit.
 1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.
 2. Provide grounding-type coupling at each end of liquid-tight flexible conduit. Provide a bonding jumper on exterior of liquid-tight flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the

conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.

3.06 CABLE CONNECTIONS

- A. Lugs. Make transformer cable connections with compression-type lugs suitable for termination of 90°C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75°C.
- B. Grounding. Ground the neutral (X0) of the transformer secondary winding in accordance with the requirements of NEC-250.30, paragraph 3.3G of Section 26 0526, and as indicated on Drawings. Connect equipment grounding conductors, system bonding jumper(s), and isolated grounding conductors to transformer neutral (X0) bus. Provide equipment bonding jumper from transformer neutral (X0) bus to transformer metallic enclosure. Expose bare metal of transformer enclosure to ensure proper contact between transformer enclosure and equipment bonding jumper.

3.07 TAP SETTING

- A. Check for damage and tight connections prior to energizing transformer. Verify removal of all shipping anchor bolts and shipping supports prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.
- C. Select the appropriate tap setting on transformer so that the actual secondary voltage is $\pm 1/2$ of a tap span at full load.

3.08 TESTING

- A. Test and record no-load amperages of all dry type transformers. Replace at no cost to Owner all transformers with no load amperage exceeding four percent of rated full load.
- B. Submit record of field testing and tap settings to the Owner's Representative and to the Architect/Engineer, in accordance with the requirements of Division 01 and Section 26 0000. Where not specified elsewhere, provide three copies of the record.
- C. Test and inspect in accordance with NETA ATS Chapter 7.2.1.1 prior to energizing.

3.09 FIELD QUALITY CONTROL

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and review test results.
- 2. Tests and Inspections:
 - a. Perform visual and mechanical inspection.
 - b. Follow NETA Acceptance Testing Specification.
 - c. Certify compliance with tests.
- B. Where integrated metering has been specified to be connected to an external network, contractor to provide the required connection and commissioning to customer's specified system.
- C. Identify non-compliant products to the engineer and replace at no cost to the customer.

END OF SECTION

SECTION 26 2416
PANELBOARDS – DISTRIBUTION AND BRANCH CIRCUIT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of distribution and branch circuit panelboards. See 26 43 13 and one line diagrams for installation of surge protective device in distribution panelboards. The panelboard used for the main service shall be service entrance rated.

1.02 REFERENCE STANDARDS

- A. ANSI/UL 50 - Cabinets and Boxes.
- B. ANSI/UL 67 - Electric Panelboards.
- C. ANSI/UL 508 - Industrial Control Equipment.
- D. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA AB 3 - Molded Case Circuit Breakers and Their Application.
- F. NEMA PB 1 - General Instructions for Proper Handling, Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.03 SUBMITTALS

- A. Provide product data on panelboards, circuit breakers and remote control switches.
- B. Provide shop drawings with a schedule for each panelboard that indicates the circuit breaker arrangement and other pertinent features. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason for a deviation. Submitted panelboard schedules must also contain confirmation of panelboard characteristics.

PART 2 PRODUCTS

2.01 ENCLOSURE

- A. Cabinet. Construct cabinets in accordance with UL 50. Use not less than 16-gauge galvanized sheet steel. Provide a minimum 4-inch gutter wiring space on each side. Reinforce cabinets and securely support bus bars and over-current devices to prevent vibration and breakage in handling. Provide cabinets without conduit knockouts. All conduit knockouts shall be made in the field. Surface-mounted panelboards in finished spaces shall have cabinet finishes to match doors and trim as specified below. In unfinished areas such as mechanical and electrical rooms, galvanized sheet steel cabinets are sufficient, provided galvanizing occurs after components are cut or sheared.
- B. Doors and Trim. Provide cabinets with door-in-door, dead-front construction. The outer door shall have a continuous piano hinge on the right side and shall provide access only to circuit breaker operating handles. The inner door shall allow for full access to the cabinet interior. Fabricate doors and trim of cold-rolled sheet steel. Equip inner doors with flush-type combination catch and key lock. Key all locks alike. Fasten trim for panelboards to cabinets by an approved means that permits both horizontal and vertical adjustment. Trim for surface-mounted panelboards must fit the cabinet with no overhang. Apply a finish to trim and doors consisting of two coats of enamel over a rust-inhibiting prime coat.

2.02 BUS

- A. Fabricate phase, neutral and ground buses of 98 percent IACS conductivity copper with rounded edges. Size bars as indicated and brace them to withstand symmetrical short circuit current as indicated on drawings. Install buses in allotted spaces so that devices can be added without additional machining, drilling or tapping. Use buses with silver-plated contact surfaces. Include copper 200% neutral bus **for 208Y/120V panelboards**. This applies to all standard

panels and electronic grade panelboards. Provide a ground bus rated as required. Provide an additional isolated ground bus where indicated on plans.

2.03 PROTECTIVE DEVICES

- A. Provide circuit breakers for the specified service with the number of poles and ampere ratings indicated.
- B. Provide breakers that are quick-make and quick-break on both manual and automatic operation. Use a trip-free breaker that is trip indicating. Incorporate inverse time characteristic by bimetallic overload elements and instantaneous characteristic by magnetic trip. Where indicated, provide ground fault circuit interrupters (GFCI). Main circuit breakers 400A and above in all panelboards shall be 100% rated. Main breakers below 400A and feeder breakers may be 80% rated. **Provide electronic trip for feeder breakers 100A and larger; Long time, Short time and Instantaneous.**
- C. For 2-pole and 3-pole breakers, use the common-trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.
- D. Unless otherwise indicated on plans, provide circuit breakers with the following interrupting ratings: 18,000 rms symmetrical amperes at rated voltage for breakers rated 277 volts, single pole or 480 volts, multipole and 10,000 rms symmetrical amperes at rated voltage for breakers rated 120V, single pole or 208 volts. Series rating of circuit breakers is not allowed. All circuit breakers shall be fully rated, unless indicated otherwise.
- E. Connect breakers to the main bus by means of a solidly bolted connection. Use breakers which are interchangeable, capable of being operated in any position within the panel. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.
- F. Cable lugs shall suitable for copper or aluminum conductors.

2.04 CIRCUIT IDENTIFICATION

- A. For each panelboard, provide a steel directory frame mounted inside the door with a heat-resistant transparent face and a directory card for identifying the loads served. Type directory as specified in Section 26 0000, paragraph 3.3.

2.05 LISTING

- A. UL 67 - Electric Panelboards.

2.06 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are Square D (BOD), Eaton Electrical (Cutler-Hammer), GE Company.

2.07 ELECTRONICS GRADE PANELBOARDS

- A. Provide electronic grade panelboard for selected distribution and branch circuit panelboards. See plans. See Section 26 4313 for surge protective device.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install panelboards in the locations shown and as recommended in NEMA PB1.
- B. Surface mounted panels shall be mounted to the wall utilizing 1 5/8" hot dipped galvanized framework. Do not mount panels directly to the wall.

3.02 MOUNTING HEIGHT

- A. Install the panelboards 6' AFF to top of panelboard.

3.03 PROTECTION

- A. Temporary Doors. Protect cabinets by a temporary door until the panelboard is energized. Temporary doors shall be 1/4-inch-thick plywood or equivalent rigid material. Temporary doors shall be installed when the cabinet is installed and shall remain closed at all times except when work is being performed inside the panelboard.
- B. Permanent Doors and Trim. Permanent doors and trim shall be installed immediately before panelboards are energized. Permanent doors and trim shall be maintained in factory condition after installation. Doors shall remain closed at all times except when the panelboard is de-energized and work is taking place within the panelboard.
- C. Cabinets. Cabinet interiors shall be maintained clean at all times. Cabinet exteriors shall be maintained free of mud, spray-on insulation, paint spray and all substances not placed on the exterior surface by the panelboard manufacturer.

3.04 LABELING

- A. Provide arc flash label per specification 26 05 73.

END OF SECTION

SECTION 26 2726 WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of wiring devices and device plates.

1.02 REFERENCE STANDARDS

- A. Americans with Disabilities Act (ADA).
- B. ANSI/IEEE 62.41 - Guide for Surge Voltages in Low-Voltage AC Power Circuits.
- C. ASHRAE 90.1-2004 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. NEMA WD 1 - General Requirements for Wiring Devices.
- E. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
- F. NEMA WD 5 - Specific-Purpose Wiring Devices.
- G. NFPA 70 - National Electrical Code (NEC).
- H. Texas Accessibility Standards (TAS).
- I. ANSI/UL 20 - General-Use Snap Switches.
- J. ANSI/UL 498 - Attachment Plugs and Receptacles.
- K. ANSI/UL 943 - Ground Fault Circuit Interrupters.
- L. UL 1449 - Transient Voltage Surge Suppressors.

1.03 RELATED WORK

- A. Section 26 0000, Electrical General Provisions.
- B. Section 26 0537, Boxes.
- C. Section 26 0553, Electrical Identification.
- D. Section 26 5100, Interior and Exterior Lighting.

1.04 SUBMITTALS

- A. Provide product data on wiring devices and device plates.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide back- and side-wired, industrial-grade, factory-fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws or by means of a factory made, listed, plug-style connector. Plug-style connector shall be touch safe while connected to branch circuit conductors and manufactured to mount at 90-degree angle to direction of insertion to allow easy mounting in outlet boxes. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.
- B. Grade. Provide industrial-grade devices unless otherwise noted or specified.
- C. Type. Provide straight-blade devices as specified herein and as indicated on Drawings. Provide locking-type receptacles (i.e., Twist-Lock) in corridors or other special type receptacles where indicated on Drawings.

2.02 WALL SWITCHES

- A. Type. Quiet type, back and side wired switches as shown.
- B. Rating. 20 amperes, 120/277 volts, unless indicated or specified otherwise.

- C. Finished Areas. Wall switches shall be toggle-style switches. Select device plates of same color, and match with receptacle, phone and data outlet device plate style. Coordinate with Architect and Owner for room finish.
- D. Listing. UL 20 and Federal Specification W-S-896.
- E. Manufacturers. The following designations are for white devices; provide devices in the color specified in paragraph 2.04, this Section.

Type	Hubbell (BOD)	Cooper	Bryant	Pass & Seymour	Leviton
S	HBL1221W	1991W	4901W	PS20AC1-W	1221-2W
S2	HBL1222W	1992W	4902W	PS20AC2-W	1222-2W
S3	HBL1223W	1993W	4903W	PS20AC3-W	1223-2W
S4	HBL1224W	1994W	4904W	PS20AC4-W	1224-2W
SK	-L	-L	-L	-L	-L

1. Key operated switch: add the indicated suffix to the above designations.
- F. Switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.
 - G. A listed manual switch having a horsepower rating not less than the rating of the motor, a thermal overload element suitable for the motor served, and marked "Suitable as Motor Disconnect", shall be permitted to serve as the disconnect means for stationary motors of 1/4 horsepower or less.
 - H. Use horsepower rated switches, with thermal overload element, approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4 hp. Horsepower rated switches shall be 30 ampere minimum, with number of poles as required.
 - I. EPO. Illuminated Emergency-Power-Off (EPO) switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or accepted substitution.
 - J. Switch terminal screws or connectors shall be designed to accommodate up to No. 10 AWG solid conductor.

2.03 RECEPTACLES

- A. Type. Back and side wired receptacles.
- B. Rating. As scheduled on Drawings.
 1. Dedicated circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC, where not scheduled or indicated otherwise on Drawings.
 2. Ground Fault Circuit Interrupter (GFCI or GFI). Refer to paragraph 2.3F, this Section.
- C. Listing. UL 498 and Federal Specification W-C-596.
- D. Manufacturers. The following designations are for white devices or manufacturer's standard device color; provide devices in the color specified in Article 2.04, this Section. Other manufacturers equal in design and function will be considered upon submittal of manufacturer's data.

NEMA Config.	Cooper	Bryant	Pass & Seymour	Hubbell	Leviton
5-20R	5362	5362	5362-AW	5362	5362A-W
GFCI	GF8300	GFR83FT	2094-W	GF-8300	8899-W

- E. Heavy Duty Locking-Blade Receptacles. NEMA WD 5. Locking-blade receptacles shall be heavy duty specification grade.
- F. Ground Fault Circuit Interrupter (GFCI). GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter.

1. End of Life. GFCI receptacles shall include End-of-Life protection, such that when the GFCI device is incapable of passing the internal self-test function, and can therefore no longer provide ground fault protection, the GFCI receptacle will either render itself incapable of delivering power, or indicate by visual or audible means that the device must be replaced
 2. Reverse Line-Load Mis-wire. GFCI receptacles shall include reverse line-line protection, such that the GFCI device will deny power to the receptacle face if it is mis-wired with the connections to the line and load terminals reversed.
 3. Listing. UL 943, current edition.
 4. Do not use feed through feature.
 5. GFCI receptacles are required throughout the building within 6 feet of sinks, including lab areas.
 6. Each GFCI device shall control only one receptacle.
 7. Where receptacle is installed in damp or wet locations provide weather resistant type GFCI receptacles.
- G. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.
- H. Weatherproof Receptacles. Receptacles specified or indicated as “weatherproof” shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified. Provide weatherproof, gasketed device covers suitable for continuous connection of cord-and-plug devices. See paragraph 2.5E, this Section.
- I. Automatic Controlled Receptacle.
1. All nonlocking-type, 125 volt, 15 and 20 ampere receptacles that are controlled by an automatic control device or incorporate control features that remove power from the outlet for the purpose of energy management or building automation shall be marked with the symbol indicated in paragraph 2.3.1.2 of this Section placed on the controlled receptacle outlet where visible after installation.
 2. Receptacle identifier:



2.04 DEVICE COLOR

- A. Supply wiring devices in white, except where device color is specified or scheduled on Drawings, and as noted below:
1. Wiring devices connected to emergency power shall be red.
 2. Isolated ground receptacles shall be orange.
 3. Key operated switches shall be gray.
 4. Automatic controlled receptacles shall be blue with blue cover plate.
- B. Coordinate color of devices and device plates with the architectural finish for that room or area. Refer to architectural Drawings and specifications. Verify color and finish with Architect and Owner's Representative.
- C. For renovation or expansion of existing facilities, provide devices and plates to match existing finishes, devices, and device plates.

2.05 DEVICE PLATES

- A. Finished Spaces.
1. Provide high abuse and impact resistant nylon device plates, with cutouts as required for devices indicated on Drawings. Edges of plates must be flush with edges of boxes.
- B. Color.
1. Device plates for receptacles connected to emergency power shall be red.
 2. Device plates for receptacles connected to normal power shall be white.
 3. Where not specified or indicated otherwise, provide device plates in white.

- C. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.
- D. Jumbo plates are not permitted.
- E. Weatherproof enclosures.
 - 1. For each GFCI receptacle specified in 2.3F and installed in wet locations, provide a weatherproof enclosure cover per NEC 406.9B(1) (Leviton 5977 DGR).
- F. Exposed Boxes in Dry Interior Spaces. Make plates of heavy cadmium-plated sheet steel. Edges of plates must be flush with edges of boxes. Screws and fasteners shall be stainless steel.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Deliver wiring devices individually wrapped in factory-fabricated containers.
- B. Handle wiring devices carefully to avoid breaking, scoring, and damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on this project.
- C. Store wiring devices in a clean, dry space, elevated above grade, and protected from weather, dirt, sunlight, and moisture.
- D. Refer to paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.02 INSPECTION

- A. Examine the areas and conditions under which wiring devices are to be installed and notify the Owner and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include a written plan for correction of deficiencies and conditions noted. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.03 DEVICE COORDINATION

- A. Where items of equipment are provided under other Sections, by other Divisions, or by the Owner, provide a compatible receptacle and device plate for the cap or plug, and cord of the equipment.

3.04 GENERAL

- A. Install wiring devices in accordance with applicable requirements of the NEC, NEMA, ANSI, and the product manufacturer recommendations.
- B. Taps, Splices and Connections. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends. Refer to Section 26 0526, Grounding and Bonding.
- C. Termination. Stranded conductors for branch circuit wiring to snap switches and receptacles shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer's recommendations. Refer to Section 26 0519, Insulated Conductors.
- D. Where more than one device occurs in one outlet box, such that the voltage between adjacent devices would exceed 300 volts, provide a barrier for isolation to comply with the requirements of NEC Article 404.8(B).
- E. Location. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough in, subject to the approval of the Constructor Inspector and the Owner's Representative.
- F. Coordination.

1. Coordinate location, mounting height, and orientation of wiring devices with adjacent outlets for other systems such as HVAC control, voice/data, security, fire alarm, etc.
 2. Communications Outlets. Where 4-plex receptacles (i.e., double duplex) are indicated or shown on the Drawings in the vicinity of communications outlets for voice, data, and telephone systems provide standard 4-inch by 4-inch recessed wall box flush with finished wall for communications outlet. Space 4-plex receptacle and communications outlet 6 inches horizontally between outside edges of adjacent boxes.
 3. Casework and Millwork. Coordinate devices installed in casework and millwork with the location, finish, and mounting arrangement of the casework and millwork. Review applicable shop drawings and coordinate the installation with applicable Division.
 4. Refer to Section 26 0537, Boxes, for additional requirements.
- G. Wiring. Devices must be completely wired and installed. Provide hot, neutral, ground, and other connections of appropriate voltage as required for proper device and luminaire function. Luminaires and lighting controls must be operating properly at final completion.

3.05 RECEPTACLES

- A. Location.
1. Install convenience outlets in a suitable steel outlet box centered at the height of 18 inches above floor, 8 inches above counters or above the backsplash level, or as indicated on the Drawings. Do not install receptacles partially in the backsplash and partially in the wall. Coordinate location with equipment and architectural Drawings.
 2. Position the center of communications outlets (telephone, data, computer and TV) 18 inches above floor or 8 inches above countertops, unless otherwise noted or indicated. Do not install communications outlets partially in the backsplash and partially in the wall. Coordinate with communications (Voice/Data) supplier, architectural Drawings, shop drawings, and millwork.
 3. Install specific-use receptacles at heights shown on Drawings.
 4. Mount receptacles generally where indicated on Drawings. The Owner's Representative reserves the right to make reasonable changes in receptacle locations without change in the contract sum.
- B. Position.
1. Install receptacles vertically with ground pole on bottom. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.
 2. Where receptacles are located adjacent to wall switches or communication outlets, group devices and mount vertically, or as indicated on Drawings.
- C. Type and Grade.
1. Provide industrial-grade receptacles unless otherwise noted or specified.
 2. Provide locking-type receptacles (i.e., Twist-Lock) in corridors or other special type receptacles where indicated on Drawings.
- D. Ground Fault Circuit Interrupter (GFCI). Provide GFCI-type receptacle for receptacles within 6-feet of a water source such as sinks. Connect branch circuit wiring to line-side terminals of GFCI receptacle. Feed through to non-GFCI receptacles is not permitted.
- E. Furniture:
1. Locate boxes serving electrified furniture as indicated on plans.
 2. Refer to Part 3 of Section 26 0537, Boxes.

3.06 WALL SWITCHES

- A. Location.
1. Set wall switches in a suitable outlet box centered at the height of 48 inches from the floor, except as otherwise shown.
 2. Where shown near doors, install switches and dimmers not less than 2 inches and not more than 12 inches from door trim.

3. Verify door swings before rough in and locate switch on the strike side of the door as finally hung. Where glass wall or glass partition is indicated or provided at strike side of door, install switch on adjacent wall and clear of door swing.
 4. Where wainscot or backsplash occurs at the 48 inches level, install device in the wall above the wainscot or backsplash or as near the 48 inch level as possible to provide the most pleasing appearance. In no case shall the switch be installed partially in the wainscot or backsplash and partially in the wall.
- B. Position. Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the job, generally up or to the left for the ON position.

3.07 DEVICE PLATES

- A. Type. Provide device plates for each outlet of the type required for service and device involved. Plates shall be provided for telecom and A/V per those documents
- B. Ganged Devices. Mount ganged devices under a single, one-piece device plate.
- C. Workmanship. Install devices and device plates level, plumb, and parallel to adjacent surfaces or trim. Devices shall be flush with the finished trim cover plates. Device plates shall be tight to surfaces over which they are installed.
- D. Patching. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner's Representative.
- E. Engraving. Engrave plates with 1/8-inch-high black letters, if designated for engraving.
- F. Labels. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, provide plates with labels to identify items being controlled, or areas being lighted. Refer to Section 26 0553 for Electrical Identification requirements.

END OF SECTION

SECTION 26 2813 - FUSES – 600 VOLT AND BELOW

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of low voltage fuses rated 600 volts and below, 6000 amperes and below.

1.02 REFERENCE STANDARDS

- A. ANSI/UL 198E - Class R Fuses.
- B. ANSI/UL 198C - High Interrupting-Capacity Fuses, Current Limiting Types, Class L.
- C. ANSI/NEMA FU 1 - Low Voltage Cartridge Fuses.
- D. ANSI/UL 248 - Fuses.

1.03 RELATED WORK

- A. Section 26 00 00, Electrical General Provisions.
- B. Section 26 05 73, Overcurrent, Protective Device Coordination Study.

1.04 SUBMITTALS

- A. Provide product data on fuses.
- B. Refer to Section 26 05 73 for submittal requirements in conjunction with short circuit and overcurrent protective device coordination study.

PART 2 PRODUCTS

2.01 VOLTAGE

- A. Provide fuses with a voltage rating suitable for the nominal voltage of the system in which they are to be applied.

2.02 TYPES

- A. Time Delay Fuses. Unless otherwise indicated, provide UL Class RK-1 time delay, current limiting fuses having 200,000 rms symmetrical amperes interrupting rating. Use on 600-ampere or smaller circuits where indicated.
- B. Non-Time Delay Fuses. Fuses indicated by "K 1" on the drawings are UL Class RK 1 non-time delay having 200,000 rms symmetrical amperes interrupting rating. Use on 600-ampere or smaller circuits supplying branch circuit panelboards, resistance heating, and where otherwise indicated.
- C. Class L Fuses. Fuses rated 601 to 6000 amperes are UL Class L with 200,000 rms symmetrical amperes interrupting rating.

2.03 MANUFACTURER

- A. Bussman.
- B. Mersen.
- C. Littelfuse.
- D. Low voltage fuses must be products of a single manufacturer.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fuses individually wrapped, in factory-fabricated containers.
- B. Store fuses in a clean and dry space and protected from weather, moisture, corrosion and damage.
- C. Handle products carefully to avoid damage to material components and finish. Damaged fuses shall be rejected and not be installed on project.

- D. Refer to paragraph 3.2 of Section 26 00 00, Electrical General Provisions.

3.02 COORDINATION

- A. Coordinate fuse selection with the short circuit and overcurrent protective device coordination study.
- B. Refer to Section 26 05 73 for additional requirements.

3.03 INSTALLATION

- A. Instructions. Follow the manufacturer's installation instructions.
- B. Fuse Clips. Check fasteners on fuse clips for tightness when installing fuses.
- C. Labels. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.

3.04 SPARE FUSES

- A. As spares, provide the greater amount of either three fuses or 10 percent of each size and type installed. Deliver the spare fuses to the Owner at the time of final acceptance of the project.

END OF SECTION

SECTION 26 2816 ENCLOSED SAFETY SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of enclosed safety switches. All switches shall be fused.

1.02 REFERENCE STANDARDS

- A. ANSI/UL 98 - Enclosed and Dead-Front Switches.
- B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches.
- C. NFPA 70 - National Electrical Code (NEC).
- D. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.03 RELATED WORK

- A. Section 26 0000, Electrical General Provisions.
- B. Section 26 2813, Fuses - 600 Volt and Below.
- C. Section 26 0573, Overcurrent Protective Device Coordination Study.

1.04 SUBMITTALS

- A. Provide product data on each type and rating of switch.
 - 1. Ratings including voltage, and horsepower or continuous current.
 - 2. Dimensioned outline drawings.
 - 3. Conduit entry/exit locations.
 - 4. Cable terminal sizes.
 - 5. Wiring diagrams.
- B. Provide arc-flash calculations and associated incident energy levels. Refer to Section 26 0573, Overcurrent Protective Device Coordination Study.

PART 2 PRODUCTS

2.01 CHARACTERISTICS

- A. Voltage. Provide switches with a voltage rating of 250 volts d-c, 240 volts or 600 volts a-c, as required for the installed system voltage.
- B. Type. Provide switches conforming to NEMA KS 1 standard for Type HD (heavy duty).
- C. Contacts. Provide switches with quick-make, quick-break contacts.
- D. Poles. Unless otherwise shown, provide 3-pole, visible blade switches.

2.02 CONSTRUCTION

- A. Enclosure. Provide NEMA 1 enclosures for switches in indoor dry locations. Provide NEMA 4X enclosures for switches located outside the building conditioned envelope and in corrosive environments, unless otherwise shown.
- B. Operating Handle. Provide a handle suitable for padlocking in the OFF position with as many as three padlocks of 5/16-inch diameter shank. Use a defeatable, front accessible, coin-proof door interlock to prevent opening the door when the switch is in the ON position and to prevent turning the switch ON when the door is open.
- C. Terminal Shield. Provide incoming line terminals with an insulated shield so that no live parts are exposed when the door is open.
- D. Neutral. Provide each switch with an isolated, fully rated neutral block. Make provisions for bonding the block to the enclosure.
- E. Ground. Provide each switch with a ground lug.

- F. Fuse Holders. Provide switches with rejection-type fuse holders which are suitable for use with fuses specified under Section 26 2813, Fuses - 600 Volt and Below. All switches shall be fused.
- G. Nameplates. Provide metal nameplates, front cover mounted, which indicate the switch type, catalog number and horsepower rating (with both standard and time delay fuses).

2.03 LISTING

- A. UL 98 - Safety Standard for Enclosed Switches.

2.04 MANUFACTURERS

- A. GE Company.
- B. Square D Company.
- C. Eaton/Cutler-Hammer.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products individually wrapped, on pallets or in factory-fabricated fiberboard type containers.
- B. Store products in a clean and dry space, elevated above grade, and protected from weather, sunlight, moisture, corrosion, dirt and damage.
- C. Handle products carefully to avoid damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on project.
- D. Refer to Paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.02 INSTALLATION

- A. Install safety or disconnect switches where indicated, in accordance with the manufacturer's written instructions, and the applicable requirements of NEC. Install safety and disconnect switches in accordance with the directions of the Owner's Representative.
- B. In general, mount switches and disconnects so that operating handle is approximately 60 inches above finished floor. Where grouped, align tops of switches.
- C. For equipment with motors larger than 1/8 hp, provide disconnect switches within sight of the motor.
- D. Mount motor and circuit disconnect enclosures, independent of equipment served, on columns or freestanding on a bolted unistrut-type or galvanized welded angle iron framework anchored to floor. Refer to Section 26 0529, Metal Framing and Supports.
- E. Switch interiors shall be maintained clean until final acceptance by Owner. Switch exteriors shall be maintained free of mud, spray-on insulation, paint spray and other substances not placed on the exterior surface by the switch manufacturer.

3.03 FUSIBLE DISCONNECT SWITCHES

- A. Provide fusible disconnect switches only. Coordinate with Divisions 14, 21, 22, 23, and equipment supplier for warranty and listing requirements of equipment approved by submittal.
- B. Coordinate fuse selection with the overcurrent protective device coordination study. Refer to Sections 26 0573.
- C. Install fuses in fusible disconnect switches. Provide permanent marking inside and outside the switch enclosure for fuse type and size.

END OF SECTION

SECTION 26 4313 SURGE PROTECTION DEVICE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.02 SUMMARY

- A. This Section specifies the furnishing and installing of type 1 Surge Protective Devices (SPDs), used as a component of a facility-wide suppression system implemented in conjunction with type 2 SPDs in branch circuit panelboards. The specified unit installed in the facility-wide suppression system shall provide effective high-energy transient voltage suppression, surge current diversion, and line control in high-exposure ANSI/IEEE C62.41-1991 environments on the load side of the facility main overcurrent protective device (OCPD). Units installed in the facility-wide suppression system are indicated by the designation SPD (Surge Protection Device) on Drawings.

1.03 STANDARDS

- A. The specified units installed in the facility-wide suppression system shall be designed, manufactured, tested, and installed in compliance with the following standards:
- B. American National Standards Institute and Institute of Electrical and Electronic Engineers:
 - 1. ANSI/IEEE C62.41.1, Recommended Practice for Surge Voltages in Low-Voltage AC power Circuits.
 - 2. ANSI/IEEE C62.45, Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- C. IEEE Standard 1100-1999 (Emerald Book): Powering and Grounding Sensitive Electronic Equipment.
- D. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
- E. Military Standards (MIL-STD 220A).
- F. National Electrical Manufacturers Association (NEMA LS1-1992/R2000).
- G. National Fire Protection Association (NFPA):
 - 1. NFPA 75, Protection of Information Technology Equipment.
 - 2. NFPA 70, National Electrical Code (NEC), Article 285.
- H. Underwriters Laboratories (UL):
 - 1. UL 248, Low Voltage Fuses.
 - 2. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - 3. UL 1449 Fourth Edition, Surge Protection Devices.

1.04 RELATED WORK

- A. Section 26 24 16, Panelboards – Distribution and Branch Circuit.
- B. Section 26 43 13, Surge Protection Device.
- C. Section 26 05 73, Overcurrent Protective Device Coordination and Arc Flash Study.

1.05 SUBMITTALS

- A. Factory Tests: Furnish certified documentation for the following tests:
 - 1. Package must include shop drawings complete with all technical information unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.

2. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
 3. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc) and are tested and multi-listed to UL 1449 4th Edition and UL 1283.
 4. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.
- B. Product Data: Submit complete product data and catalog cutsheets describing each unit provided. Make submittals in accordance with the requirements of Division 01 and Section 26 05 00, Electrical General Provisions.
- C. Field Testing: Submit written procedures and forms to be used for field testing to demonstrate compliance with these specifications, as required under Part 3 of this Section. Testing procedures and forms shall include range of permissible values for each recorded parameter. Include list of test instruments and materials to be used for field testing, to include manufacturer, model, accuracy, and applicable steps of field testing procedures.
- D. Submittals after fabrication:
1. Instruction manual describing each unit provided. Manual shall conform to the requirements of Operations and Maintenance (O&M) manuals per Section 26 05 00, Electrical General Provisions.
 2. Spare Parts: A list of customer-replaceable spare parts for each unit installed in the facility-wide suppression system shall be included in the unit installation, operation and maintenance instructions. Spare parts shall be quickly and easily field-replaceable.
 3. Field Testing: Submit to the Owner's Representative and to the Architect/Engineer documentation of field testing performed in accordance with Part 3 of this Section, demonstrating compliance with the requirements of this Section. Where not specified otherwise, provide three copies to the Architect/Engineer and one copy to the Owner's Representative.
- E. Panelboards: Refer to Section 26 24 16, Panelboards – Distribution and Branch Circuit, for submittal requirements for distribution and branch circuit panelboards as indicated in Construction Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Square D
- B. GE
- C. Current Technology
- D. Eaton.

2.02 SPD RATINGS

- A. Refer to drawings for operating voltage, configuration.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 4th Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
- C. Unit shall have not more than 10% deterioration or degradation of the UL1449 4th Edition Voltage Protection Rating (VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protection available at all times.
- D. Protection Modes of UL1449 4th Edition Voltage Protection Rating (VPR) (6kV, 3kA) for grounded WYE/delta and with voltages of (480Y/277). 3-Phase, 4 wire circuits.
- E. Provide equipment with the following ratings:

System Voltage	Mode	MCOV	B3 Ringwave	C3 Comb. Wave	UL 1449 Fourth Edition VPR Rating
120/208	L-G	150	400	650	700
	N-G	0	350	500	900
	L-L	300	400	950	900
277/480	L-N	320	550	1125	900
	L-G	320	850	1075	1200
	N-G	0	700	900	1200
	L-L	550	650	1950	1800

- F. If SPDs are submitted with integral disconnect ratings must be adjusted to comply with UL 1449 4th Edition.
- G. Provide SPDs with nominal discharge current rating of 20kA/mode.
- H. Surge Rating – Provide service entrance SPDs with a minimum surge rating of 200kA per mode at the main switchboards/switchgear in each building. Provide branch circuit and distribution panel SPDs with a minimum surge rating of 80kA per mode.
- I. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
 - 1. 100 kHz at 41 db.
 - 2. All other frequencies should be 31 db or better.
- J. Each Unit shall provide the following features:
 - 1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
 - 2. Field testable while installed.
- K. Suppression/Filter System: UL 1283 minimum insertion loss obtained utilizing MIL-STD-E220A 50 ohm insertion loss methodology. (100 kHz - 1 MHZ): 34 dB (50:1).

2.03 FUSING

- A. Fuse Components Identification and Surge Rating: The surge rating (8 x 20 μ sec) of the fuse shall be greater than the combined surge current rating of downstream connected suppression elements.
- B. Suppression Components Identification and Surge Rating: The suppression elements connected in series with fuse elements shall provide the suppression elements published 8 x 20 μ sec surge current rating. The rating of the suppression elements shall be less than the rating of upstream fusing elements.
- C. Surge Performance: Fusing shall be required to meet the single pulse surge current testing requirements described above.
- D. Isolation: The unit shall have each MOV fused and designed to operate only in the event of a MOV failure within the unit.
- E. UL Rating: Fusing shall be 200kAIC UL248 Recognized.

2.04 BUSSING

- A. Transient Conduction Path: Full magnitude transient currents shall be conducted on low-impedance solid copper bussing. Printed circuit boards traces shall not be used to conduct or shunt transient voltage surge currents.

2.05 MONITORING

- A. Visual: Monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the SPD for each phase of protection. The lights shall also indicate when suppressor protection has degraded to a value of less than 50%.

- B. Alarm: The unit shall include an audible alarm with battery backup, sized for a minimum of 30 minutes, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring.

2.06 ENCLOSURE

- A. Provide an SPD assembly that is UL listed.
- B. If required to maintain a UL listing of both the SPD and the associated distribution equipment, then provide the SPD in a separate NEMA Type 12 enclosure sized per the SPD manufacturer's recommendations. Install the SPD per manufacturer recommendations.
- C. SPDs interior to the gear they are protecting will not be permitted.
- D. Finish: Exterior and interior steel surfaces shall be cleaned and finished with electrostatically applied "powder coat" thermoset enamel baked over a rust-inhibiting phosphatized coating. Exterior finish color shall be manufacturer's standard gray, ANSI 49 or ANSI 61, to match finish of associated panelboard.

2.07 LISTING

- A. Units shall be UL 1449, Fourth Edition, listed and labeled as a Type 1 Surge Protection Device.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver surge protection devices, components and accessories individually wrapped, on pallets or in factory-fabricated fiberboard type containers, and protected from weather and damage.
- B. Store surge protection devices, components and accessories in a clean and dry space, elevated above grade, and protected from weather, sunlight, moisture, dirt, and corrosion.
- C. Surge protection devices, components, and accessories shall not be used as work tables, scaffolds, or ladders.
- D. Handle surge protection devices, components, and accessories carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and not be installed on project.
- E. Refer to Section 26 00 00, Electrical General Provisions.

3.02 INSTALLATION

- A. General: Install surge protection device (SPD) internal to the electrical distribution equipment in accordance with manufacturer's wiring diagrams and written instructions and the applicable requirements of the NEC, NEMA, ANSI, local codes, and Owner requirements.
- B. Install the SPD enclosure external to the gear enclosure. Extend phase conductors from SPD to disconnecting means in the electrical equipment, as indicated on Drawings. Extend neutral and ground conductors from SPD to lugs at the neutral and ground busses, in accordance with manufacturer instructions. Connection leads shall not exceed 18 inches from the SPD to the circuit breakers:
 - 1. Where not otherwise indicated or specified, terminate SPD phase conductors to three single-pole circuit breakers in the panelboard connected by a handle tie.
 - 2. Where manufacturer instructions and UL-listing require a 3-pole circuit breaker as disconnecting means and overcurrent protection for the surge protection device, provide a 3-pole circuit breaker as the disconnecting means between the SPD and main bus.
 - 3. Provide overcurrent device for SPD connection to panelboard main bus, sized in accordance with manufacturer recommendations. Refer to Section 26 24 16, Panelboards – Distribution and Branch Circuit.
- C. Wire Size: Manufacturer's recommended wire size for unit supplied. Where wire size is not indicated by manufacturer, provide conductors of same size as grounding conductor connected to the ground bus of the panelboard, #2 AWG minimum per phase, neutral, and ground. Use stranded copper conductor with THWN insulation, unless otherwise noted.

- D. Equipment interiors shall be maintained clean until final Owner acceptance. Equipment exteriors shall be maintained free of mud, spray-on insulation, paint spray and other substances not placed on the exterior surface by the equipment manufacturer.
- E. Inspection: Thoroughly inspect surge protection device and panelboard for items such as loose connections and presence of foreign materials and remedy prior to energizing the panelboard. Bolted connections shall be torqued to the manufacturer's recommendations.

3.03 SYSTEM TESTING

- A. Upon completion of installation, provide the start-up and testing services of a factory-authorized and factory-trained local service representative. The tests shall include:
 - 1. Off-Line testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. Compare field test results to factory benchmark test parameters supplied with each individual unit.
 - 2. On-Line testing: Verification that suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage and by visual inspection.
 - 3. Voltage measurements from Line-to-Ground (L-G), Line-to-Neutral (L-N), Line-to-Line (L-L), and Neutral-to-Ground (N-G), taken at the time of the testing procedure.

3.04 DOCUMENTATION AND REPORTING

- A. Record results of field testing and compare to factory benchmark test parameters supplied with each individual surge protection device. Indicate that the integrity of neutral-to-grounds bonds was verified through testing and visual inspection, and that grounding bonds were observed to be in place.
- B. Submit to the Owner's Representative and to the Architect/Engineer copies of the startup test results and the factory benchmark testing results for confirmation of proper suppression filter system function, as required by paragraph 1.05D.3, this Section. Provide number of copies as required by Division One and Section 26 00 00, Electrical General Provisions; and three copies where not otherwise specified.

3.05 SYSTEM WARRANTY

- A. The SPD system shall be warranted against defective materials and workmanship for a period of ten years.
- B. Warranties shall conform to the requirements of Division 01 and Section 26 05 00, Electrical General Provisions.

END OF SECTION

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the furnishing and installation of luminaires complete with lamps, ballasts, and other accessories. Provide poles for exterior luminaires requiring such.

1.02 REFERENCE STANDARDS

- A. EPA SW 846 - Test Methods for Evaluating Solid Waste.
- B. NFPA 70 - National Electrical Code (NEC).
- C. NFPA 101 - Life Safety Code.
- D. UL 924 - Emergency Lighting and Power Equipment.

1.03 RELATED WORK

- A. Section 26 0000, Electrical General Provisions.
- B. Section 26 0533, Raceways.

1.04 SUBMITTALS

- A. Submit product data on each luminaire, emergency lighting unit, exit sign, and pole, with separate sheet for each luminaire, assembled by luminaire "type" in alphabetical order, with the proposed luminaire, ballast or Driver, lamps, and accessories clearly labeled. Submit at one time in booklet form.
 - 1. Include with submittal data dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency, efficacy, and visual comfort probability.
- B. LED: Provide documentation for performance of LED luminaires including LM 79, LM 80 reports and L70, L80 or L85 test results. Provide documentation for listed tolerances for variation in temperature color, or "binning". Binning documentation shall include MacAdam steps diagram with range of binning clearly indicated. Provide testing data that clearly indicates listed environmental conditions for installation of luminaire including ambient temperature.
 - 1. LED luminaires with remote drivers shall clearly indicate required wattage and voltage tolerance of driver and maximum range for which driver can be installed remote to LED luminaire.
 - 2. Provide power requirements for complete LED fixture package clearly indicating the lumen package and power consumption of the entire fixture package.
 - a. Data indicating only lumen package and power requirements for individual LED modules incorporated into the complete fixture package is not acceptable.
- C. Samples.
 - 1. When requested in writing by the Owner's Representative or the Architect/Engineer, furnish samples of luminaire types.
 - 2. Deliver samples for luminaire types as requested, at a time and place designated by the requestor (Owner's Representative or the Architect/Engineer).
 - 3. Samples shall be complete product models as proposed for use on the project.
 - 4. Furnish samples to the Owner at no additional cost.
 - a. Samples shall not be installed on the project without the written consent of the Owner's Representative and the Architect/Engineer.
 - b. Upon written concurrence from the Owner's Representative, samples furnished for the project may be retained by the Contractor for delivery as "spares" following Owner's acceptance of the completed project.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Lens. Lenses for luminaires shall have a nominal thickness of 0.125 inch.
- B. Disconnecting Means. Provide luminaires for indoor locations with factory-installed disconnecting means complying with NEC-410.73(G).
- C. Frames.
 - 1. Frames shall be flush steel. Alternate materials are indicated in Luminaire Schedules on Drawings.
- D. Manufacturer. Luminaires are specified by type and manufacturer in the Luminaire Schedule on the Drawings. Equivalent products of manufacturers listed below will be considered upon submission of product data in accordance with paragraph 1.7 of Section 26 0000 and with paragraph 1.04 of this Section.
 - 1. LED. Acuity/Lithonia, Columbia, Cooper, Finelite, Focal Point, Kenall, LiteControl, Peerless, Zumtobel, Kurt Versen, LSi, Vantage, Kenall, HE Williams.
 - 2. Exterior area lighting. Philips/ Lumec, Lithonia, Kim, KW Industries, King Luminaire.
 - 3. Exit Signs. Refer to paragraph 2.6 this Section.
 - 4. Emergency Lighting Units. Refer to paragraph 2.4, this Section.

2.02 LAMPS

- A. General. Provide lamps for luminaires. Types are specified in the Luminaire Schedule on the Drawings.
- B. Light Emitting Diodes (LED) or Solid State Lighting
 - 1. Provide luminaire package with temperature variance limited to three MacAdam steps as defined in ANSI C78.377.
 - 2. Provide luminaire that is factory tested as a complete package with a LM-79 and LM-80 report.
 - 3. Provide luminaire with individual LED boards. Replacement of individual LED boards shall be capable to be performed in the field and shall not require replacement of the entire unit or fixture.
 - 4. Provide fixture with minimum 5 year warranty covering complete luminaire package.
 - 5. Provide LEDs with phosphorous coating, for creation of white LEDs, at the individual LEDs and not at the luminaire lens or housing.
 - 6. Provide luminaire with quick disconnect for LED drivers and individual LED boards.
 - 7. Provide LED fixtures compatible with 0-10V or DALI non-proprietary controls.
 - 8. Provide LED luminaires with appropriately sized heat sink.

2.03 BALLASTS/DRIVERS

- A. General. Provide drivers for luminaires as required and as scheduled.
- B. Light Emitting Diode (LED) Drivers
 - 1. UL Listed as a complete assembly with luminaire,
 - 2. RoHS and FCC compliant.
 - 3. Minimum 5 year warranty.
 - 4. Comply with NEMA 410 for in-rush current limits.
 - 5. UL Class 2 power limited per UL1310.
 - 6. UL dry and damp location listed.
 - 7. Power factor greater than 0.90 and <20% THD.
 - 8. Driver shall operate at specified input voltage with sustained variation of +/- 10% with no damage to the driver.
 - 9. Integral surge protective device.
 - 10. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
 - 11. Minimum operating temperature -20C.

12. Driver output regulated +/- 5% over published load range. Output shall be compatible with LED board in specified luminaire.
 13. Output current controls local to the driver (trimpot or programmable).
 14. If specified on the Drawings, the driver shall dim within the range specified on the fixture schedule with no flicker.
 15. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.
- C. Listings.
1. LED - UL1310 - Class 2 power supplies
- D. Fuses. Provide in-line fuses in base of the pole for pole-mounted luminaires.

2.04 EMERGENCY BATTERY PACK/BALLAST

- A. Where indicated on luminaire schedule or plans, provide luminaires with emergency ballasts. Emergency ballasts shall automatically provide for a minimum of 90 minutes of illumination in the event of loss of normal power to the building. Where larger capacity is indicated on plans or schedules, provide unit with larger capacity.
- B. Emergency battery packs/ballasts shall comply with the following requirements:
1. Exceed the NEC, LSC, and UL 90-minute requirements, and carry the UL label.
 2. Contain high-temperatures nickel cadmium batteries that are maintenance free and fully recharge within 24 hours.
 3. Are backed by full (non pro-rata) warranties, 5-year for linear fluorescent lamps and 2-year for compact fluorescent lamps.
 4. Capable of operating one or two lamps, with minimum lumen output as indicated on the Drawings.
- C. Manufacturer. Bodine, and the scheduled luminaire manufacturers.

2.05 EMERGENCY LIGHTING UNITS

- A. See plans.

2.06 EXIT SIGNS

- A. Manufacturer. Refer to the scheduled luminaire manufacturers.
- B. See plans.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Deliver luminaires, exit signs, emergency lighting units, and accessories individually wrapped in factory-fabricated fiberboard type containers.
- B. Handle luminaires, exit signs, emergency lighting units, and accessories carefully to prevent breakage, denting and scoring the luminaire finish. Do not install damaged units.
- C. Store luminaires, exit signs, emergency lighting units, and accessories in a clean, dry space, elevated above grade, and protected from the weather and sunlight.
- D. Refer to Section 26 0000, Electrical General Provisions.

3.02 COORDINATION

- A. Prior to ordering luminaires, check the type of ceilings to be installed in each room and verify that the luminaires are proper and compatible for the type of ceiling as specified and as indicated on the architectural Drawings. Provide a frame compatible with the type of ceiling in which the luminaire is installed. Refer to the Drawings and the Architectural Room Finish Schedule for the specified ceiling type. Advise the Owner's Representative of discrepancies before placing the luminaire order.

- B. Check the building electrical system requirements and architectural finishes, and regardless of the catalog number prefixes and suffixes shown, furnish luminaires with the proper trim, frames, plaster rings, supports, hangers, stems, mounting brackets, ballasts, voltage rating, and other miscellaneous appurtenances to properly coordinate with said conditions. Verify with Owner's Representative prior to ordering.
- C. If a luminaire type designation is omitted, furnish luminaire of the same type as shown for rooms of similar usage. Verify with Owner's Representative before purchase and installation.
- D. Examine the areas and conditions which luminaires are to be installed and notify the Owner's Representative and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include written plan for correction of deficiencies and conditions noted. Do not proceed with the work until unsatisfactory conditions have been corrected.
- E. Verify that the occupancy sensors are compatible with the specified ceiling systems as indicated on the Drawings. Advise the Architect/Engineer of discrepancies before placing the device order.
- F. Verify that the fluorescent dimmers are compatible with the specified dimming ballasts, as indicated on Drawings.
- G. Coordinate luminaire installation with lighting controls.

3.03 INSTALLATION

- A. Install luminaires in accordance with the manufacturer's written instructions, Owner's requirements, the applicable requirements of NEC and local and national Codes, Standards, and regulations.
- B. Install luminaires at locations as shown on the Drawings, install aligned, aimed, and leveled. Install luminaires in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials.
- C. Support.
 - 1. Provide hangers and support members for luminaires as required for proper installation. Provide appurtenances which include stud supports, stems, mounting brackets, frames and plaster rings.
 - 2. Support luminaires from the building structure or from furring channels. Furring channels must be a minimum size of 1-1/2 inches. Luminaires in suspended ceilings shall be supported in accordance with NEC 410.16.
 - 3. Fasten luminaires securely to structural support members of the building. Support grid-type lay-in luminaires from the structure above at each corner of luminaire. 1/4 inch expansion slip ring anchorage with eye and ceiling-type support wire is permitted. Two wires may be supported by one anchorage if required by construction conditions, such as obstructions by other system. Solid pendant luminaires shall be plumb.
 - 4. Provide support for 1/2 inch pre-manufactured flexible metal conduit (FMC) whips from structure above. Whips shall not touch ceiling system as finally installed. Whips shall be kept 12 inches clear of ceiling except where required for termination at luminaires. Use of "fixture support wire installation" with caddy clip is permitted.
 - 5. Flexible metal conduit from junction box to luminaire shall not touch the ceiling as finally installed.
- D. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.
- E. Surface Mounted Luminaires.
 - 1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of luminaires.
 - 2. Where ceiling system has not been certified to support weight of luminaires, luminaires shall be supported at four points near each corner of luminaires.
 - 3. Provide a minimum 5/8" air space between the luminaires and the ceiling.

- F. Recessed Luminaires.
 - 1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaires clean and free of visible dust, debris, or fingerprints with lamps operational at time of acceptance of work.
 - 2. Recessed fluorescent luminaires in lay-in grid shall be supported independently from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of luminaires. Size of wire shall be capable of supporting weight of luminaires. This requirement is separate and apart from hanger wire requirements of the ceiling grid.
 - 3. Recessed luminaire trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. Components shall be accessible through the ceiling opening.
- G. Protect installed luminaires from damage during the remainder of the construction period.
- H. Luminaires must be completely wired and lamps installed. Luminaires must be operating properly at final completion.
- I. Adjustment.
 - 1. Adjust luminaires to illuminate intended areas as directed.
 - 2. Adjust exterior luminaires during hours of darkness. Where acceptable to the Owner's Representative, exterior luminaires may be adjusted during daylight hours; verification of adjustments shall be conducted during hours of darkness.
- J. Upon completion of installation of interior luminaires, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- K. Immediately before final observation, clean luminaires, inside and out, including plastics and glassware, and adjust trim to properly fit adjacent surface, replace broken or damaged parts and lamp, and test luminaires for electrical as well as mechanical operation.
- L. Lamp Disposal. The procedure for disposal of lamps that contain mercury shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

3.04 TESTING

- A. The Contractor shall demonstrate to the Owner the proper operation of luminaires, systems and equipment specified in this Section and related Sections. The Contractor shall adjust, repair or replace as necessary components that do not perform as specified, until able to demonstrate proper operation of equipment in normal, automatic, manual, emergency, power-loss, and power-restored modes of operation, as applicable.

3.05 SYSTEM WARRANTY

- A. The system shall be warranted against defective materials and workmanship for a period of five years including, but not limited to, metal corrosion, color retention, lamps, ballasts, dimming drivers, etc.
- B. Warranty period shall begin from the date of substantial completion.

3.06 SPARE PARTS

- A. Provide 10% spare LED drivers for each type and rating.
- B. Provide 10% spare lenses for each type of interior lighting.

3.07 TRAINING

- A. Provide 4 hours training at Substantial Completion of the project for the lighting control system.

END OF SECTION

SECTION 28 3100 FIRE ALARM SYSTEM

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Division 01, General Requirements and other provisions of the contract documents apply to this work.
- B. This Section intends to describe an integrated fire detection and voice evacuation system to be intelligent device addressable, analog detecting, low voltage and modular with multiplex communication techniques, in full compliance with all applicable codes and standards. The features described in this specification are a requirement for this project and shall be furnished by the successful contractor.
 - 1. The system as described shall be installed, tested, and delivered in full operating condition. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification whether itemized or not.
 - 2. All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years. The equipment manufacturer shall have an installed base of analog systems as a reference. In the interest of job coordination, the installing contractor shall contract with a single source for supplying job materials, services, and programming, including final inspection/test services for the fire alarm system.
 - 3. The equipment, space requirements, expansion capabilities and features specified were selected to meet the requirement for this project
 - a. Manufacturers. All requirements listed in this specification shall apply to all manufacturers. Listing as acceptable shall not be construed as approval for equipment not performing to the requirements set forth herein.
 - 1) Notifier. (Basis of Design / Existing System)
 - 4. All new devices shall connect into the existing fire alarm system.

1.02 MATERIALS AND SERVICES

- A. The system shall include, but not be limited to the following elements:
 - 1. Circuit interface panels including all modules.
 - 2. Power supplies, batteries and battery chargers.
 - 3. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.
 - 4. Voice/Audible and visual evacuation signals.
 - 5. Wiring and raceway.
 - 6. Installation, testing and certification and training.

1.03 REFERENCE STANDARDS

- A. The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.
 - 1. Factory Mutual (FM). FM AG Approval Guide.
 - 2. National Fire Protection Association (NFPA).
 - a. NFPA 13 Standard for the Installation of Sprinkler Systems (2013).
 - b. NFPA 25 Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems (2014).
 - c. NFPA 70 National Electrical Code (2014).
 - d. NFPA 72 National Fire Alarm and Signaling Code (2013)

- e. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems (2015).
- f. NFPA 101 - Life Safety Code (2015).
- 3. Underwriters' Laboratories, Inc. (UL).
 - a. Appropriate UL Standards.
 - b. UL FPED.
- 4. Texas Department of Licensing and Regulation.
- 5. Americans with Disabilities Act.
- 6. International Building code and the respective fire code.

1.04 QUALIFICATIONS OF THE INSTALLER

- A. Before commencing work, submit data showing that the contractor has successfully installed fire alarm systems of the same type and design as specified, or that they have a firm contractual agreement with a subcontractor having the required manufacturers' training and experience. The contractor shall include the names and locations of at least two installations where the contractor, or the subcontractor above, has installed such systems. Specify the type and design for each system and furnish documentation that the system has performed satisfactorily for the preceding 18 months. Layout to be performed and installation to be supervised by a licensed supervising fire alarm planner with the Texas State Fire Marshal's Office as a minimum.

1.05 MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a representative or technician from the manufacturer of the system, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State of Texas. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the Owner's personnel in the system operation, maintenance and programming.

1.06 SUBMITTALS

- A. The contractor shall include the following information in the equipment submittal:
 - 1. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.
 - 2. Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. At a minimum, data shall be submitted on the following:
 - a. Circuit interface panels including all modules.
 - b. Power supplies, batteries and battery chargers.
 - c. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.
 - d. Audible and visual evacuation signals and devices.
 - e. Circuiting, including conduit and wire sizes.
 - 3. Data describing more than one type of item shall be clearly marked to indicate the type the contractor intends to provide for options not crossed out in submittal material will be furnished for the project. All submittal material shall be complete. Partial submittal will not be evaluated and will be rejected without comment. The contractor shall submit copies of UL listing or FM approval data showing compatibility of the proposed device or appliance and the panel being provided.
 - 4. The fire alarm system subcontractor or manufacturer shall offer, for the owner's consideration at the time of system submittal, a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.
- B. For use in system test, a complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.
 - 1. The following information shall be inscribed on the cover:
 - a. "OPERATION AND MAINTENANCE MANUAL"

- b. Building location.
 - c. The name of the contractor, system manufacturer and system subcontractor.
 - d. The name and phone number of the fire department required to respond to alarms at the project location.
- 2. The manual shall be legible and easily read with large drawings folded and contained in pockets. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item of equipment and a control sequence describing start up instructions. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.
- C. Upon completion of the installation, record drawings shall be submitted on each system before final acceptance of the work. The contractor shall furnish to the Owner a set of record drawings including system diagrams for each system. Refer to Division 1 for submittal requirements.
- D. Complete and submit to the Owner a Certificate of Compliance in accordance with NFPA 72.

1.07 SYSTEM FUNCTION

- A. The system shall be a complete, electrically supervised multiplex style fire detection and voice evacuation system with intelligent analog alarm initiation, to be device addressable and annunciated as described.
 - 1. The maximum number of devices on a single signaling circuit shall not exceed 50, in order to avoid catastrophic loss of device communications in the event of a raceway destruction, with a capacity of 50 reporting system inputs and 50 system control outputs.

Systems capable of serving in excess of 50 devices to be addressed on as single analog communications network shall be wired and controlled in a Class A configuration including isolation circuitry limiting any short circuit fault to a maximum of 50 addresses and/or a single smoke zone, whichever is less. Device wiring in the Class A configuration shall be installed in a manner eliminating the possibility of exiting wiring sharing the same raceway as the entry wiring for any device.

 - a. Devices attached to the signaling circuit shall be individually identifiable at the control panel for alarm and trouble indication. Smoke detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning, and tested by a single technician using the panel field test routine.
 - b. Sensitivity settings of individual detectors shall be automatically or manually adjustable from the control panel to reduce the incidence of false alarms caused by environmental conditions.
 - c. The analog signaling circuits shall be installed in the fire alarm control panel enclosure or in remote circuit interface panel enclosures.
 - d. Analog signaling circuits shall support selectable Class B or Class A wiring using loop isolator modules.
 - 2. The system shall support intelligent analog smoke detection, manual station, water flow, supervisory, security, and status monitoring devices. Fire alarm, supervisory, trouble, security and status shall each be treated as a separate level of alarm, each with its own level of priority. The system shall also support amplifiers and voice/visual circuits.
 - 3. The panel shall be UL listed as a test instrument for the measurement and logging of the sensitivity of connected intelligent analog ionization and photoelectric smoke detectors connected to the control panel or any remote circuit interface panel to comply with the bi-annual sensitivity logging requirements of NFPA 72.
 - a. The measurements shall be discrete voltage readings, accurate to .01 VDC. The readings shall be dynamic, providing a constant display of voltage shifts of the device being tested when in the sensitivity voltage list mode.

- b. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. An output shall be provided, together with a desktop computer based utility program to allow the data acquired in the sensitivity testing mode to be downloaded into a laptop computer and utilized in a data base program to formulate a complete system history.
 - c. When programmed, any system connected light refraction style smoke detector shall be capable of self adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction. This adjustment shall keep the relationship between the sensing chamber voltage and the programmed alarm threshold voltage constant to prevent false indications or failure to alarm in the presence of smoke. Data contained in a memory bank on each detector so programmed, shall maintain an average of the chamber voltage in determining the threshold setting for the device. The threshold setting installed in memory within each device shall maintain programmed operation in all cases, including default and default alarm modes. All devices programmed with this feature shall be automatically tested by the control panel once every twenty four hours to assure their ability to detect and report an alarm condition. This test shall be done as a background routine and shall remain transparent to the user. In the event of a test failure, the control panel shall report a trouble message for the failed device.
 - d. Trouble messages displayed by the system LCD displays and logged to system printers and memory shall be programmed with a custom label as selected by the owner to identify the origin by cabinet, room number or other information meaningful to assist maintenance employees.
- 4. The system shall annunciate a pre-clean trouble condition when any smoke detector reaches 80% of the allowable threshold movement within the prescribed UL window due to gradual contamination, signaling the need for service, and eliminating unwanted alarms. Upon reaching 100% of the allowable movement, a second "Detector Dirty" message with a trouble condition shall be displayed.
 - a. The trouble report shall annunciate the specific location of the smoke detector requiring service. All analog smoke detectors installed in the system shall include this feature.
 - b. Upon completion of the cleaning of the device, the system shall reestablish the average chamber voltage file, determining if the detector sensitivity falls within the required window, and display a "Detector Cleaned" message. The detector cleaning shall be logged to the system history file.
- 5. Any intelligent analog smoke detector shall include a selectable alarm verification capability. This feature shall provide automatic verification of smoke detector alarms as described by NFPA 72. The system shall have the capability of logging to historical memory, the time and date of all unverified alarm events in order to track activity and generate reports indicating maintenance requirements prior to failures within the system.
- 6. All external circuits shall be listed as power limited circuits per the National Electric Code. Power limitation shall be provided using on board, self restoring solid state thermal devices. Units using fuses or manually restorable circuit breakers for this purpose or requiring board replacement or exchange will not be acceptable.
- 7. The system shall recognize initiating of an alarm and indicate the alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.
 - a. Each circuit interface panel shall be capable of operation in its own degrade mode. In this mode, the system shall receive an alarm from any intelligent analog or conventional initiating device. It shall activate local indicating appliances and remote or auxiliary connect circuits.
 - b. The system shall indicate a trouble condition during degrade mode operation and shall give a visual indication of an alarm condition.

- c. Detector operation in the degrade mode shall continue at the alarm threshold previously programmed. Systems returning detectors to a common default value in degrade mode shall not be acceptable.
8. The system shall provide a default operation program to allow reporting of alarms from installed devices before loading of custom system software.
9. The system shall report alarms from installed devices but not yet added to the system custom program. Alarm reports from these devices shall activate indicating appliance circuits.
10. The system shall perform time based control functions including automatic changes of specified smoke detector sensitivity settings. Time based functions shall be controlled by specifying time periods or actual dates. It also shall provide the ability to control these functions on an exception basis using a holiday schedule.
11. The system shall provide a one person field test initiated from the control panel of either the complete system or a specified area supported from either the master control panel or any remote circuit interface panel, maintaining full function of areas not under test.
 - a. Field test shall be usable in a silent or audible mode. When in the audible mode, the signals shall audibly annunciate alarms, troubles and device types, each in a way identifiable by the testing technician.
 - b. All field test activity shall be logged to historical memory. It shall be possible to download historic memory to a data base program prior to, and subsequent to the walk test in order to establish a continuous system history. Historic memory shall accommodate a minimum of 800 events to prevent overflow during testing.
12. The system shall be provided with eight levels of password protection with up to forty passwords. In addition the system shall provide for up to sixty four password protected sublevels protecting functions or groups of functions under operator control. Passwords and functions shall be field programmable.
13. The system shall be programmed in the field via a laptop computer. All programmed information shall be stored in nonvolatile memory after loading into the control panel. No special programming terminal or prom burning shall be required and the system shall continue in service during reprogramming. Systems requiring on line terminal programming or not capable of mass reading of panel software for offsite documentation or editing will not be considered acceptable.
 - a. During program reading or loading, the system shall retain the capability for alarm reporting.
 - b. The system shall read to a PC for program editing. System program shall be stored in digital format and all programming shall be multilevel password protected.
 - c. A U.L. recognized programming utility shall be furnished to compare all altered functions, and input or output addresses, listing all related functions, inputs and output addresses that are affected by the program changes. These items shall constitute a minimum for required certification re-testing of the system in addition to the system device percentage mandated by the codes. Systems not providing this utility shall not be acceptable due to the expense related to complete re-testing for re-certification after program changes.
14. The system shall provide status indicators and control switches for all of the following functions:
 - a. Audible and visual evacuation alarm circuit zone control.
 - b. Status indicators for sprinkling system waterflow and valve supervisory devices.
15. The system shall be listed by the UL for configuration as an approved NFPA 13 fire suppression system deluge and pre-action releasing system.

1.08 SYSTEM ZONING

- A. Each intelligent addressable device on the system shall be displayed at the fire alarm control panel by a unique alpha numeric label identifying its location.

1.09 SYSTEM OPERATION

- A. Activation of any fire alarm initiating device shall cause the following actions and indications, unless otherwise noted below:
 - 1. Display a custom message, describing the device originating the alarm condition at the main fire alarm control panel and remote annunciator.
 - 2. Report to a central monitoring station via a U.L. listed system. Provisions for fiber connectivity and a dialer shall both be provided.
 - 3. Sound an alarm tone for a minimum of 2 cycles proceeding and following an automatic digital voice message over all alarm circuits. At the end of the voice message, the alarm tone shall resume. The audio alarm signals shall sound alternately until the signal silence switch is operated.
 - a. All audio operations (speaker circuit selection and alarm tone/voice messages and timing variations) shall be activated by the system software, so that future changes can be implemented without rewiring or hardware additions. Audible signals shall be silenceable from the fire alarm control panel by an alarm silence switch. The alarm indication shall be transferred to a visual indicator on the control panel and the alarm signals shall resound for a subsequent alarm condition, reported by a different device. Visual signals shall be programmable to flash until system reset or alarm silencing. All notification devices shall be deactivated simultaneously per NFPA 72 24.4.2.9.2.
 - b. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow greater than or equal to a single head.
 - c. Status lights next to speaker selection switches on the control panel shall indicate which of the three messages each speaker circuit is distributing.
 - d. Provisions for total building paging shall be accomplished by an 'All circuits switch'.
 - 4. Record within the non-volatile system historical memory, the occurrence of the event, the time and date of occurrence and the device initiating the event. In addition, all operator actions shall be logged to system history with time and date.
 - 5. Activation of an AHU duct detector shall shutdown that AHU only and shall not sound a general alarm.
- B. Activation of any alarm verified smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described in 1.9A above, cause the recall of that bank of elevators to the terminal floor and the lockout of controls. In the event of recall initiation by a detector in the terminal floor lobby, the recall shall be to the alternate floor. Activation of any heat detector in the elevator machine room/pit shall activate the elevator recall in accordance with NFPA 72 section 21.3.7.
- C. Activation of any air duct detectors shall shutdown that unit and provide supervisory signal only; no alarm condition.
- D. Activation of any supervisory circuit; i.e., supervised valve closure, air pressure abnormal, low temperature, fire pump trouble shall cause the following actions and indications:
 - 1. Display the origin of the supervisory condition report at the main fire alarm panel and remote annunciator alphanumeric LCD display.
 - 2. Activate supervisory audible and visual signals. Audible signals shall be silenced from the fire alarm control panel by an alarm acknowledge switch. The supervisory indication shall be transferred to a visual indicator on the control panel and the supervisory signals shall resound for a subsequent supervisory condition, reported by a different device.
 - 3. Record within system history the occurrence of the event, the time of occurrence and the device initiating the event.
- E. Receipt of a trouble report; i.e., primary power loss, open or grounded initiating or signaling circuit wiring, open, grounded or shorted indication system wiring, device communication failure, battery disconnect at the fire alarm control panel shall cause the following actions and alarms.
 - 1. Display at the main fire alarm panel and remote annunciator alphanumeric LCD display, the origin of the trouble condition report.

2. Activate trouble audible and visual signals at the control panel.
 - a. Audible signals shall be silenced from the fire alarm control panel and remote annunciator by a trouble acknowledge switch. The trouble indication shall be transferred to a visual indicator on the control panel and the trouble signals shall resound for a subsequent trouble condition reported by a different device.
 - b. Trouble conditions which have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
 3. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
- F. Submittal.
1. Submit product specifications, fabrication shop drawing, and wiring diagrams.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANEL

- A. Fire alarm control pane is existing to remain.
- B. Manufacturer: Field verify.

2.02 FIRE ALARM SYSTEM POWER SUPPLIES

- A. Existing to remain. Verify additional load.

2.03 DETECTOR BASES

- A. Detector Bases – Detector bases shall be low profile, surface or flush mounted in a standard 4" square by 2-1/8" deep box. Bases shall be able to accept photoelectric, ionization or heat detectors.

2.04 SMOKE DETECTORS-PHOTOELECTRIC

- A. Furnish and install intelligent analog smoke detectors with features and characteristics as follows:
 1. Have an LED that flashed during normal operation.
 2. Be self adjusting for airborne contaminants.
 3. Have clear, distinct visual alarm indication.
 4. Be programmed to have alarm verification.

2.05 DUCT DETECTORS-PHOTOELECTRIC

- A. Furnish and install intelligent analog duct detectors with features and characteristics as follows:
 1. Report to fire alarm panel as a supervisory alarm.
 2. Have clear, distinct visual power and alarm indications.
 3. Be programmed to have alarm verification.
 4. Have extended visual indicators if mounted above ceiling located as close to duct detector as possible.
 5. Install duct detectors in all supply and return ductwork/plenums. The exact quantity and location of detectors shall depend upon ductwork layout, size, installation etc. In general, a duct detector shall be located in a straight section of the supply air ductwork, a minimum of six duct widths downstream of the unit. If a minimum of six duct widths is not possible, a duct detector shall be located downstream of the main ductwork, in each section of ductwork that branches off from the main ductwork. For multi zone units the same rules apply and a duct detector shall be located in each duct section exiting the air handling unit. The exact location and quantity of duct detectors shall be based on the final installed ductwork configuration.

2.06 FIRE SPRINKLER SYSTEM DETECTION AND SUPERVISION

- A. Furnish sensors for installation by the fire sprinkler system contractor and provide system interconnection for the following functions.

1. Waterflow switches, vane type, with adjustable pneumatic retard of 0 - 75 seconds, single pole double throw switch calibrated for actuation when flow rate equals 10 GPM or greater.
2. Outside screw and yoke valve supervisory switches in sizes as required for monitoring valves. The single pole double throw supervisory switch shall activate an off normal report within one half turn of the valve.

2.07 INTELLIGENT SUPERVISED CONTROL MODULE

- A. Furnish and install for the control of supervised relays, contactors, audible signal circuits, visual signal circuits, distributed speaker circuits, intelligent supervisory and control modules including features as follows:
 1. The modules shall be suitable for two wire operation and communications on intelligent analog alarm detection loops. Address assignments shall be accomplished electronically.
 2. The module shall display a steady LED in the normal power or standby power condition, when in the activated state.
 3. The module shall be suitable for semi-flush or surface mounting in a 2" deep, 4" square or double gang electrical outlet box having a depth of 3 1/2".
- B. Modules shall be available to supervise reverse polarity supervised indicating circuits utilizing 24VDC or audio circuits utilizing 25VRMS or 70.7VRMS. It shall be possible to configure the module for control of motor contractors and AC voltages to 115VAC.
 1. All connected field wiring shall be supervised for opens, short circuits and grounded circuits.
 2. All controlled circuits shall be power limited at 1.5A, produced by self-restoring thermal components. Units requiring circuit replacement for restoration of outputs are not acceptable.
 - a. Signal outputs shall be supported in either Class B or Class X configuration.
 - b. The module shall report a trouble condition in the event of loss of the 24VDC signal operating supply voltage.

2.08 EVACUATION SIGNALS

- A. Speakers: Shall be of the polarized 24-Vdc type. Speaker shall be UL listed for fire alarm voice evacuation use. Speakers shall be designed to be mounted on a wall, ceiling or other suitable rigid surface and shall be capable of being surface, semi flush, or flush mounted. Speakers shall be multi-tap. Settings shall be 1/16, 1/8, 1/4, 1/2, 1, 2 or 4 watts.
- B. Strobe Light: ADA visual notification appliances shall be comprised of a xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. Provide a unit that is ADA compliant with an output no less than 15 candela. The Lexan lens shall be pyramidal in shape to allow better visibility. Provide a red lens on selected strobes where indicated on plans. Strobe light candela ratings have been shown on the plans. However, contractor is responsible for sizing strobes per NFPA 72 based on room size and device location. Units shall be installed 80" above finished floor. All strobes within the same line of site shall be synchronized. Candela ratings have been shown on the plans. These ratings shall be verified based on the room size and NFPA requirements. Where there are discrepancies The NFPA requirements for candela rating shall take precedence over the values shown on the plans. Provide multi-tap strobes to allow for a full range of candela settings. Settings shall be 15/75, 30/75, 75 or 110 candela. Circuits for strobes shall allow for capacity to increase strobe intensities one setting for all strobes. Provide spare devices equal to 1% of the total number of new devices provided for this project.
- C. Speaker/Strobe combination: Standard, ADA Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes or speakers. The unit shall be complete with a tamper resistant, Pyramidal shaped lexan lens with Fire lettering visible from a 180-degree field of view. The front panel or bezel that is constructed of UL Listed Noryl, may be inverted so that the lens is below the audible device. Integral Xenon strobe shall provide 8000 peak candlepower and be adjustable from 1 to 3 flashes per second. Provide a unit approved for

ADA compliance. Strobe shall be multi-tap type to allow for a full range of candela settings as indicated in paragraph G. Xenon strobe shall provide 4-wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/visual unit shall be UL listed for its intended purpose. Speaker shall be multi-tap type to allow for different audio settings as indicated in paragraph F. Provide spare devices equal to 1% of the total number of new devices provided for this project.

- D. The evacuation signals shall be available in flush, semi-flush, or surface versions as required for signal locations shown on the contract documents. Signals shall be mounted using a listed outlet box, and as required, tile bridges. Signals shall be available in visual only and combination to satisfy all required project applications. Visual only and combination audio/visual alarms shall be white with red identification lettering. Identification lettering shall be confirmed by owner.

PART 3 EXECUTION

3.01 DESIGN AND INSTALLATION DRAWINGS

- A. Show a general layout of the complete system including equipment arrangement. It shall be the responsibility of the fire alarm contractor to verify dimensions and assure compatibility with all other systems interfacing with the fire alarm system.
 - 1. Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification. For addressable alarm initiation devices, the system identifier shall be the system address for that device. Signals shall be sequentially numbered as the address of the controlling module.
 - 2. Indicate on the point to point wiring diagrams, interconnecting wiring within the panel between modules, and connecting wiring to the field device terminals.
 - 3. Provide mounting details of FACP and other boxes to building structure, showing fastener type, sizes, material and embedded depth where applicable.

3.02 INSTALLATION

- A. Perform work in accordance with the requirements of NEC, NFPA 70, and NFPA 72.
- B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
 - 1. Use clamping devices for attaching to structural steel, or when clamping is impractical, obtain written authority to weld or to drill.
 - 2. Fasten equipment to concrete or masonry with expansion anchors.
 - 3. Fasten equipment to drywall by screws into studs, and to metal wall panels by weld studs, bolts or self tapping metal screws.
 - 4. Do not install conduit raceways and boxes in positions that interfere with the work of other trades.
 - 5. Attach nameplates on panels or other components as specified.
 - 6. Heat detectors shall be mounted within two feet of sprinkler heads. Set heat detectors for 135 degree activation.
 - 7. Smoke detectors shall be installed no closer than 3 feet to a supply air grill.

3.03 CONDUIT

- A. All wiring shall be installed in conduit. Minimum conduit size shall be 3/4 inch.

3.04 BOXES, ENCLOSURES AND WIRING DEVICES

- A. Boxes shall be installed plumb and firmly in position.
 - 1. Extension rings with blank covers shall be installed on junction boxes where required.
 - 2. Junction boxes served by concealed conduit shall be flush mounted
 - 3. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

4. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers. All boxes shall be red.

3.05 CONDUCTORS

- A. Each conductor shall be identified as shown on the shop drawings with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of each wire termination. Marker legends shall be visible.
 1. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
 2. Wiring for analog loop circuits and speaker circuits shall be 18 AWG twisted. Wiring for strobe circuits shall be a minimum 14 AWG.
 3. Splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer's recommendations.
 4. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- B. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.
- C. Provide Type CI, 2 hour rated circuit integrity cable or type MI cable where required per code.
- D. All wiring shall be installed in conduit.

3.06 CERTIFICATE OF COMPLIANCE

- A. Complete and submit to the Owner in accordance with NFPA 72.

3.07 FIELD QUALITY CONTROL

- A. Testing, General.
 1. All intelligent analog devices shall be tested and logged for correct address and sensitivity using test equipment specifically designed for that purpose. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the system address, initials of the installing technician and date.
 2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
 - a. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.
 - b. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector, shall be corrected.
 - c. Test reports shall be delivered to the acceptance inspector as completed.
 3. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
 - a. Ladders and scaffolds as required to access all installed equipment.
 - b. Multimeter for reading voltage, current and resistance.
 - c. Intelligent device programmer/tester.
 - d. Laptop computer with programming software for any required program revisions.
 - e. Two way radios, flashlights, smoke generation devices and supplies.
 - f. Spare printer paper.
 - g. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
 - h. Decibel meter.
 4. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.
 5. System wiring: fire alarm circuits shall be tested for continuity, grounds, and short circuits.

B. Acceptance testing.

1. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the Acceptance Inspector in accordance with NFPA 72, and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.
2. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.
3. A complete listing of all device labels for alpha numeric annunciator displays and logging printers shall be prepared by the installing contractor prior to the ATP.
4. The acceptance inspector shall use the system record drawings in combination with the documents specified under Paragraph 3.1 during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
 - a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - 1) Open, shorted and grounded intelligent analog signaling circuit.
 - 2) Open, shorted and grounded network signaling circuit.
 - 3) Open, shorted and grounded conventional zone circuits.
 - 4) Open, shorted and grounded speaker circuits.
 - 5) Intelligent device removal.
 - 6) Primary power or battery disconnected.
 - 7) Incorrect device at address.
 - b. System evacuation alarm indicating appliances shall be demonstrated as follows:
 - 1) All alarm notification appliances actuate as programmed
 - 2) Audibility and visibility at required levels.
 - c. System indications shall be demonstrated as follows:
 - 1) Correct message display for each alarm input at the control panel and each remote alphanumeric display.
 - 2) Correct annunciator light for each alarm input at each annunciator and color graphic terminal as shown on the drawings.
 - 3) Correct printer logging for all system activity.
 - d. Secondary power capabilities shall be demonstrated as follows:
 - 1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - 2) System primary power shall be restored for forty-eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.
 - 3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
5. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.
 - a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
 - b. In the event that software changes are required during the ATP, a utility program shall be furnished by the system manufacturer to compare the edited program with the original. This utility shall yield a printed list of the changes and all system functions, inputs and outputs effected by the changes. The items listed by this program shall be the minimum acceptable to be re-tested before calling for resumption of the ATP. The

printed list and the printer log of the retesting shall be submitted before scheduling of the ATP.

- c. The acceptance inspector may elect to require the complete ATP to be performed again if, in his opinion, modifications to the system hardware or software warrant complete re-testing.

3.08 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
 1. System record drawings and wiring details including one set of reproducible masters and drawings on CD ROM or DVD in a DXF format suitable for use in a CAD drafting program.
 2. System operation, installation and maintenance manuals
 3. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
 4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
 5. System program showing system functions, controls and labeling of equipment and devices. Also provide a digital copy of the system file.

3.09 TEST EQUIPMENT

- A. The Contractor shall furnish all test equipment as required to program devices and test the system, specifically an intelligent device tester and programmer.

3.10 WARRANTY AND SERVICES

- A. The contractor shall warrant the entire system against mechanical and electrical defects for a minimum of 18 months. This period shall begin upon completed certification and test of the system. Coordinate with Division 1 requirements.
- B. During the warranty period, the fire alarm system subcontractor or manufacturer shall provide at no additional charge the inspection, parts, maintenance, testing and repair in full compliance with the requirements of NFPA 72. Response time to any trouble call shall not be more than 2 hours with resolution within 24 hours.
- C. The installation contractor shall furnish training as follows for a minimum of four employees of the system user:
 1. Training in the receipt, handling and acknowledgement of alarms.
 2. Training in the system operation including manual control of output functions from the system control panel.
 3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
 4. The total training requirement shall be a minimum of 6 hours but shall be sufficient to cover all items specified.

END OF SECTION