University of Texas at Arlington
UTA Vivarium Design Services
Arlington, Texas

SPECIFICATION PACKAGE
Issue for Bid
March 16, 2017
Rev. A
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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. Owner-furnished products.
   4. Access to site.
   5. Work restrictions.
B. Related Requirements:
   1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
   2. Section 013100 “Project Management and Coordination” for administrative procedures and requirements during construction.
   3. Section 013300 "Submittal Procedures" for administrative requirements governing the preparation and submittal of the Contractor's submittal schedule.
   4. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
   5. Section 017700 “Closeout Procedures” for administrative and procedural requirements for contract closeout.

1.3 PROJECT INFORMATION
A. Project Identification: Life Science 5th Floor Vivarium Renovation, The University of Texas at Arlington, Texas.
   1. Project Location: Life Science Building, 501 S. Nedderman Dr., Arlington Texas.
B. Owner: University of Texas at Arlington.
1.4 WORK COVERED BY CONTRACT DOCUMENTS
   A. The Work of the Project is defined by the Contract Documents and consists of the following:
   B. Renovation of the existing 5th floor vivarium at the Life Science Building including adding a barrier space.
   C. Type of Contract
      1. Project will be constructed under a single prime contract.

1.5 OWNER-FURNISHED PRODUCTS
   A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
   B. Owner-Furnished Products:
      1. Door hardware locksets
      2. Furniture/Lab Equipment
   C. Owner-Furnished and Installed Products:
      1. Interior Signage

1.6 ACCESS TO SITE
   A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
   B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
      1. Contractor shall use the building’s freight elevator only. Other elevators are off limits to construction personnel.
   C. Adjacent Construction: Access to the loading dock of the Life Science Building will be coordinated with Hunt Construction (SEIR Building). The access will be through Hunts site fence.
   D. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
      1. Schedule deliveries to minimize use of driveways and entrances by construction operations.
      2. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 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. Nonsmoking Building: Smoking is not permitted within the building, on the construction site or on University property, (University of Texas Arlington is a non-smoking campus).

1.8 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.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION
SECTION 012300

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 bidders 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 the 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 alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES
A. Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.
B. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of each accepted 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.
2. Before commencing Alternate Work, submit an updated copy of the Contractor’s construction schedule showing the revised sequence, commencement and completion dates for all phases of Work.
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 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Refer to RFP NO. FM2017-010 for schedule of alternates, Alts-01 diagram, and proposal form.

END OF SECTION
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 requests for substitutions made after award of the Contract.
B. Related Requirements:
   1. Section 012300 "Alternates" for products selected under an alternate.
   2. Section 013300 "Submittal Procedures" for requirements for submitting Contractor's Construction Schedule and the Schedule of Submittals.
   3. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS
A. Substitutions: Requests for changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor are considered requests for "substitutions."
   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.
   3. The following are not considered substitutions:
      a. Substitutions requested by Bidders during the bidding period, and accepted prior to award of Contract, are considered as included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
      b. Revisions to Contract Documents requested by the Owner or the Owner's Designated Representative.
c. Specified options of products and construction methods included in Contract Documents.
d. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit PDF copy (and samples as applicable) of each request for consideration. Identify product or fabrication or installation method to be replaced. Include related Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use CSI Form 13.1A or form attached at end of this section.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
   b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
   d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   e. Samples, where applicable or requested.
   f. Certificates and qualification data, where applicable or requested.
   g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
   h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
   i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES and/or applicable code organization.
   j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
   k. Cost information, including a proposal of change, if any, in the Contract Sum.
   l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
   m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 14 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   b. Use product specified if Architect/Engineer does not issue a decision on use of a proposed substitution within time allocated.

4. Requests for substitution will be considered if received within 7 days after Notice to Proceed. Requests received more than 7 days after commencement of the Work may be considered or rejected at the discretion of the Owner’s Designated Representative.
1.5 QUALITY ASSURANCE
   A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

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

1.7 SUBSTITUTIONS
   A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 14 days prior to time required for preparation and review of related submittals.
      1. Conditions: Architect/Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer 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.
            1) This includes requests related to an "or equal" clause or similar language in the Contract Documents.
         b. Substitution request is fully documented and properly submitted.
         c. Requested substitution will not adversely affect Contractor's construction schedule.
            1) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
         d. Requested substitution has received necessary approvals of authorities having jurisdiction.
            1) The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
         e. Requested substitution is compatible with other portions of the Work.
            1) The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
         f. Requested substitution has been coordinated with other portions of the Work.
            1) The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
         g. Requested substitution provides specified warranty.
            1) The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provide the required 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.

   C. Substitutions for Convenience (where allowed): Architect/Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect/Engineer.
      1. Conditions: Architect/Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer 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/Engineer for 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.

D. Where a proposed substitution involves more than one prime Contractor, each Contractor shall cooperate with the other Contractors involved to coordinate the Work, provide uniformity and consistency, and to assure compatibility of products.

E. Contractor's submittal and Architect's/Engineer's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 Substitution Request Form

A. Use form on next page for submitting substitutions where allowed.
SECTION012500.13
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 “Substitution Procedures:"

1. SPECIFIED PRODUCT OR SYSTEM
   Substitution request for: ________________________________
   Specification Section No.: ________________ Article/Paragraph: ________________

2. REASON FOR SUBSTITUTION REQUEST
   SPECIFIED PRODUCT . . . PROPOSED PRODUCT . . .
   □ Is no longer available.  ☑ Will reduce construction time
   □ Is unable to meet project schedule.  ☑ Will result in cost savings of
   □ Is unsuitable for the designated application.  $_______________ to Project
   □ Cannot interface with adjacent materials.  ☑ Is for supplier’s convenience
   □ Is not compatible with adjacent materials.  ☑ Is for subcontractor’s convenience
   □ Cannot provide the specified warranty.  ☑ Other: ________________
   □ Cannot be constructed as indicated ________________
   □ 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 is 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:

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<tr>
<td>Variations:</td>
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(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 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: ____________________________
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 Architect’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 Architect’s approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered and Addendum is issued; and that Architect’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. **ARCHITECT’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: _______________________________

Architect 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; Architect to prepare Change Order.
- Substitution is not accepted.
- Owner will pay Architect directly for redesign fees.
- Include Architect’s Additional Service fee for implementing the substitution in the Change Order.

By: ____________________________________________

Date: _______________________________

(Owner’s Representative)

END OF FORM
SECTION 012600
CONTRACT MODIFICATION PROCEDURES

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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 Requirements:
1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
2. Section 013100 “Project Management and Coordination” for administrative procedures and requirements during construction.

1.3 MINOR CHANGES IN THE WORK
A. Architect/Engineer will issue through the Owner’s Designated Representative supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, either via Field Bulletin or on AIA Document G710.
   1. Where minor changes in work are indicated via Owner’s Designated Representative response to Requests for Information, Contractor shall immediately notify Owner if the Contractor believes the response will require adjustment to the Contract Sum or Contract Time, prior to commencing work covered by the response.

1.4 PROPOSAL REQUESTS
A. Owner-Initiated Proposal Requests: Architect/Engineer through the Owner’s Designated Representative will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Architect/Engineer through the Owner’s Designated Representative are for information only. Do not consider as instructions either to stop work in progress or to execute the proposed change.
Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

1) 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.

2) Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

3) Include costs of labor and supervision directly attributable to the change.

4) 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.

5) Quotation Form: Use CSI Form 13.6B "Proposal Worksheet Summary" and 13.6C "Proposal Worksheet Detail". AIA G709 or Field Bulletin form.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect/Engineer through the Owner’s Designated Representative.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

7. Proposal Request Form: Use form acceptable to Owner’s Representative and Architect/Engineer.

1.5 CHANGE ORDER PROCEDURES

A. On Owner’s approval of a Work Change Proposal Request, Architect/Engineer through the Owner’s Designated Representative will issue a Change Order for signatures of Owner and Contractor on AIA Document G701 or form acceptable to Owner.

1. No verbal order, verbal statement, or verbal direction of the Owner or his duly appointed representative shall be treated as a change order.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: When the Owner and Contractor are not in total agreement on the terms of a Change Order Proposal Request, the Architect/Engineer through the Owner’s Designated Representative may issue a Construction Change Directive on AIA Document G714. 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 Construction 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
## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY
A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFI.
   4. Digital project management procedures and/or project website.
   5. Project meetings.
B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
C. Related Requirements:
   1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
   2. Section 013300 "Submittal Procedures" for administrative requirements governing the preparation and submittals required under this section.
   3. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   4. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
   5. Section 230010 "Basic Mechanical Requirements" for specific coordination drawing requirements for mechanical installations.
   6. Section 260500 "Basic Electrical Requirements" for specific coordination drawing requirements for electrical installations.

### 1.3 DEFINITIONS
A. RFI: Request for Information. Request from Owner, Architect/Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.
1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
   1. Post copies of list in project meeting room, in temporary field office, in web-based Project software directory, and in prominent location inbuilt facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

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

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Pre-installation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity, or for installation of products and materials fabricated off-site by separate entities.
   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 coordination drawings 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, plumbing 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 Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect/Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

h. Refer to Section 230010 - Basic Mechanical Requirements and Section 260500 - Basic Electrical Requirements for specific coordination drawing requirements for mechanical and electrical installations.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.

2. Plenum Space: Indicate sub-framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.

3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.

4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Mechanical and Plumbing Work: Show the following:
   a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
   b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
   c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:
   a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
   b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
   c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
   d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:
   a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect/Engineer will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect/Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect/Engineer through the Owner’s Representative will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
   1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
   2. File Preparation Format: DWG, Version, operating in Microsoft Windows operating system.
   3. File Submittal Format: Submit or post coordination drawing files using PDF format.
   4. Architect/Engineer will furnish to the Owner’s Representative upon request one set of digital data files of Drawings for use by the Contractor in preparing coordination digital data files.
      a. Architect/Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
      b. Digital Data Software Program: Drawings are available in Autodesk AutoCad 2017
      c. Contractor shall execute a data licensing agreement in the form of AIA Document C106 or Agreement form acceptable to Owner and Architect/Engineer.

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified. All RFIs should be posted directly to the project collaboration site with notifications sent via email to the Architect/Engineer and Owner’s Designated Representative.
   1. Architect/Engineer will return without response those RFIs submitted to Architect/Engineer by other entities controlled by Contractor.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor’s work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
   1. Project name.
   2. Project number.
   3. Date.
   4. Name of Contractor.
   5. Name of Architect/Engineer.
   6. RFI number, numbered sequentially.
   7. RFI subject.
   8. Specification Section number and title and related paragraphs, as appropriate.
   9. Drawing number and detail references, as appropriate.
   10. Field dimensions and conditions, as appropriate.
   11. Contractor’s suggested resolution. If Contractor’s suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   12. Contractor’s signature.
   13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
      a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect/Engineer and Owner’s Designated Representative.
   1. Attachments shall be electronic files in PDF format.

D. Architect/Engineer’s Action: Architect/Engineer will review each RFI, determine action required, and respond. Allow 5 working days for Architect/Engineer’s response for each RFI. RFIs received by Architect/Engineer after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Architect/Engineer's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect/Engineer's action may include a request for additional information, in which case Architect/Engineer's time for response will date from time of receipt by Architect/Engineer of additional information.

3. Architect/Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect/Engineer in writing within 5 working days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project software. Include the following:

1. RFI Log Date
2. Project name.
3. Name and address of Contractor.
4. Name and address of Architect/Engineer.
5. RFI number including RFIs that were returned without action or withdrawn.
6. RFI description.
7. Date the RFI was submitted.
8. Date Architect/Engineer's response was received.
9. Identification of related Minor Change in the Work, Change Order’s, and Proposal Request, as appropriate.

F. On receipt of Architect/Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect/Engineer within 5 working days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Architect/Engineer's Data Files Not Available without prior approval: Architect/Engineer will not provide Architect/Engineer's CAD drawing digital data files for Contractor's use during construction.

B. Web-Based Project Software: Use Architect/Engineer's web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project software site includes, at a minimum, the following features:

   a. Compilation of Project data, including Contractor, subcontractors, Architect/Engineer, Architect/Engineer's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
   b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
   c. Document workflow planning, allowing customization of workflow between project entities.
   d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
   e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.

*Processing and tracking of payment applications.*

h. Processing and tracking of contract modifications.

i. Creating and distributing meeting minutes.

j. Document management for Drawings, Specifications, and coordination drawings, including revision control.

k. Management of construction progress photographs.

l. Mobile device compatibility, including smartphones and tablets.

2. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect/Engineer. Provide data in locked format to prevent further changes.

3. Provide the following web-based Project software packages under their current published licensing agreements:

   a. PM Web.

**C. PDF Document Preparation:** Where PDFs are required to be submitted to Architect/Engineer, prepare as follows:

   1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

   2. Name file with submittal number or other unique identifier, including revision identifier.

   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

**A. General:** Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

   1. **Attendees:** Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect/Engineer of scheduled meeting dates and times a minimum of 10 working days prior to meeting.

   2. **Agenda:** Prepare the meeting agenda. Distribute the agenda to all invited attendees.

   3. **Minutes:** Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect/Engineer, within three days of the meeting. Include distribution to parties that should have been present.

   4. **Schedule updating:** Revise the construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

**B. Preconstruction Conference:** Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect/Engineer, but no later than 14 days after execution of the Agreement.

   1. **Attendees:** Authorized representatives of Owner, Architect/Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

   2. **Agenda:** Discuss items of significance that could affect progress, including the following:

      a. Responsibilities and personnel assignments.

      b. Safety procedures.

      c. Tentative construction schedule.

      d. Phasing.

      e. Critical work sequencing and long lead items.

      f. Designation of key personnel and their duties.

      g. Lines of communications.

      h. Use of web-based Project software.
i. Procedures for processing field decisions and Change Orders.

j. Procedures for RFI's.

k. Procedures for testing and inspecting.

l. Procedures for processing Applications for Payment.

m. Distribution of the Contract Documents.

n. Submittal procedures.

o. Preparation of Record Documents.

p. Use of the premises and existing building.

q. Work restrictions.

r. Working hours.

s. Owner's occupancy requirements.

t. Responsibility for temporary facilities and controls.

u. Procedures for moisture and mold control.

v. Procedures for disruptions and shutdowns.

w. Construction waste management and recycling.

x. Parking availability.

y. Office, work, and storage areas.

z. Equipment deliveries and priorities.

aa. First aid.


c. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect/Engineer of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:


   b. Options.

   c. Related RFIs.

   d. Related Change Orders.

   e. Purchases.

   f. Deliveries.

   g. Submittals.

   h. Review of mockups.

   i. Possible conflicts.

   j. Compatibility requirements.

   k. Time schedules.

   l. Weather limitations.

   m. Manufacturer's written instructions.

   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. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect/Engineer, but no later than 60 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, Architect/Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
   a. Preparation of Record Documents.
   b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
   c. Procedures for completing and archiving web-based Project software site data files.
   d. Submittal of written warranties.
   e. Requirements for preparing operations and maintenance data.
   f. Requirements for 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.

E. Progress Meetings: Conduct progress meetings at weekly intervals or agreed upon intervals.

1. Coordinate dates of meetings with preparation of payment requests.

2. Attendees: In addition to representatives of Owner and Architect/Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      1) Review schedule for next period.
b. Review present and future needs of each entity present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Deliveries.
   5) Off-site fabrication.
   6) Access.
   7) Site use.
   8) Temporary facilities and controls.
   9) Progress cleaning.
   10) Quality and work standards.
   11) Status of correction of deficient items.
   12) Field observations.
   13) Status of RFIs.
   14) Status of Proposal Requests.
   15) Pending changes.
   16) Status of Change Orders.
   17) Pending claims and disputes.
   18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
## SECTION 013200  CONSTRUCTION PROGRESS DOCUMENTATION

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### 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 Construction Schedule.
2. Daily construction reports.
3. Material location reports.
4. Site condition reports.
5. Unusual event reports.

#### 1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity and occurs only when all preceding activities have been completed.
E. **Float:** The measure of leeway in starting and completing an activity.
   1. Float time belongs to Owner.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. **Resource Loading:** The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 **INFORMATIONAL SUBMITTALS**

A. **Format for Submittals:** Submit required submittals in the following format:
   1. PDF file.

B. **Contractor's Construction Schedule:** Initial schedule, of size required to display entire schedule for entire construction period.
   1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

C. **CPM Reports:** Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. **Activity Report:** List of 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 each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
   3. **Total Float Report:** List of activities sorted in ascending order of total float.
   4. **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 monthly intervals prior to applications for payment.

E. **Site Condition Reports:** Submit at time of discovery of differing conditions.

F. **Unusual Event Reports:** Submit at time of unusual event.

1.5 **QUALITY ASSURANCE**

A. **Scheduling Consultant Qualifications:** An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect/Engineer'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.
CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
   1. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
   2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

C. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial 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.

D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect/Engineer.
   2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
   5. Commissioning Time: Include no fewer than 15 days for commissioning.
   6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect/Engineer's administrative procedures necessary for certification of Substantial Completion.
   7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

E. 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 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 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 construction.
      b. Limitations of continued occupancies.
      c. Uninterruptible services.
      d. Partial occupancy before Substantial Completion.
      e. Use-of-premises restrictions.
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.
m. Commissioning.

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. Temporary enclosure and space conditioning.
   c. Permanent space enclosure.
   d. Completion of mechanical installation.
   e. Completion of electrical installation.
   f. Substantial Completion.

F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

G. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
   1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.

H. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
   1. Unresolved issues.
   2. Unanswered Requests for Information.
   3. Rejected or unreturned submittals.
   4. Notations on returned submittals.
   5. Pending modifications affecting the Work and the Contract Time.

I. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate final completion percentage for each activity.
J. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

K. Distribution: Distribute copies of approved schedule to Architect/Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 CPM SCHEDULE REQUIREMENTS

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within 10 days of date established for the Notice of Award. Outline significant construction activities for the first 30 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
   1. Include each significant construction activity.
   2. Coordinate each activity in the network with other activities.
   3. Schedule each construction activity in proper sequence.
   4. Indicate completion of the Work in advance of the date established for Substantial Completion.

C. Tabulation of Submittals: With submittal of the startup network diagram, include tabulation by date of submittals required during the first 90 days of construction. List those required to maintain orderly progress of the Work, and those required early because of long lead time for manufacture or fabrication.

D. Distribution: Distribute the startup network diagram to all parties that need to know about construction activities that are scheduled early.

   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
      a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect/Engineer’s approval of the schedule.
   2. Conduct educational workshops to train and inform key Project personnel, including subcontractors’ personnel, in proper methods of providing data and using CPM schedule information.
   3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
   4. Use “one workday” as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

F. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths. Include every activity having a bearing on the time required to complete the Work. Provide the best data available for generation of the network diagram and CPM schedule.
   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.
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 CPM schedule 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. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect/Engineer's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
   a. Each activity cost shall reflect an appropriate value subject to approval by Architect/Engineer.
   b. Total cost assigned to activities shall equal the total Contract Sum.

G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

H. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
   1. Contractor or subcontractor and the Work or activity.
   2. Description of activity.
   3. Main events of activity.
   4. Immediate preceding and succeeding activities.
   5. Early and late start dates.
   6. Early and late finish dates.
   7. Activity duration in workdays.
   8. Total float or slack time.
   9. Subcontract or trade designation
   10. Average size of workforce.
   11. Dollar value of activity (coordinated with the schedule of values).

I. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
   1. Identification of activities that have changed.
   2. Changes in early and late start dates.
   3. Changes in early and late finish dates.
5. Changes in the critical path.
6. Changes in total float or slack time.

J. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts one week before each regularly scheduled progress meeting.

1.9 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.
11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
14. Orders and requests of authorities having jurisdiction.
15. Change Orders received and implemented.
16. Construction Change Directives received and implemented.
17. Services connected and disconnected.
18. Equipment or system tests and startups.
19. Partial completions and occupancies.
20. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
INDEX PAGE

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. Submittal schedule requirements.
      2. Administrative and procedural requirements for submittals of Shop Drawings, Product Data, Samples, reports, and qualifications to verify that products, materials and systems proposed for use comply with provisions of the Contract Documents.

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

1.3 DEFINITIONS

   A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
B. Informational Submittals: Written and graphic information and physical samples that do not require Architect/Engineer'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.


E. Coordination Drawings are a special type of Shop Drawing that show the relationship and integration of different construction elements that require close and careful coordination during fabrication or during installation to fit in the restricted space provided or to function as intended. Refer to Section 013100 "Project Management and Coordination" for submitting coordination drawings.

F. Field Samples are full-size physical examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the Work will be judged.

G. Mock-ups are full size assemblies for review of construction, coordination, testing, or operation; they are not Samples. Refer to Section 014000 “Quality Requirements” for mockup types, requirements, and procedures.

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, testing, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect/Engineer 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 startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

   a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

   a. Scheduled date for first submittal.
   b. Specification Section number and title.
   c. Submittal Category: Action; informational.
   d. Name of subcontractor.
   e. Description of the Work covered.
   f. Scheduled date for Architect/Engineer's final release or approval.
   g. Scheduled dates for purchasing.
   h. Scheduled date of fabrication.
   i. Scheduled dates for installation.
   j. Activity or event number.
1.5 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect/Engineer.
4. Name of Construction Manager.
5. Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   a. 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).
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
12. Drawing number and detail references, as appropriate.
13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect/Engineer.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect/Engineer on previous submittals. Indicate by highlighting, encircling, or otherwise indicating deviations on each submittal or noting on attached separate sheet. Include the Contractor's signed certification stating that information submitted complies with requirements of the Contract Documents.

D. Submit Coordination Drawings where required for integration of different construction elements. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilization of the space available.

E. PDF Submittals for Web-Based Project Software: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect/Engineer and Owner's Designated Representative.
3. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using transmittal form.
   a. Project name
   b. Date
   c. Destination (To:)
   d. Source (From:)
   e. Names of subcontractor, manufacturer and supplier
   f. Category and type of submittal
1.6 **SUBMITTAL PROCEDURES**

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
   a. Architect/Engineer through Owner’s Designated Representative will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
   a. Owner’s Designated Representative and Architect/Engineer reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect/Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect/Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 10 working days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect/Engineer's consultants, Owner, or other parties is indicated, allow 15 working days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect/Engineer and to Architect/Engineer's consultants, allow 15 working days for review of each submittal. Submittal will be returned to Architect/Engineer before being returned to Contractor.
   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect/Engineer.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Owner’s Designated Representative and Architect/Engineer's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, and installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Owner’s Designated Representative and Architect/Engineer's action stamp.

G. Do not proceed with installation of materials, products and systems until a copy of Product Data applicable to the installation is in the installer's possession.

H. Do not permit use of unmarked copies of submittals in connection with construction.

1.7 SUBMITTAL REQUIREMENTS

A. Administrative Submittals: Refer to all Division 1 Sections, individual specification sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:
   1. Permits.
   2. Applications for payment.
   3. Performance and payment bonds.
   4. Insurance certificates.
   5. Listing of subcontractors.

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 unsuitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
      a. Submit a preliminary single copy of Product Data where selection of options by the Owner’s Designated Representative is required. Unless the Owner’s Designated Representative or Architect/Engineer observes noncompliance with provisions of the Contract Documents, the submittal may serve as the final submittal of Product Data.
   3. Include the following information, as applicable:
      a. Manufacturer’s catalog cuts.
      b. Manufacturer’s product specifications.
      c. Manufacturer’s installation instructions.
      d. Manufacturer’s printed recommendations
      e. Standard color charts.
      f. Statement of compliance with specified referenced standards.
      g. Testing by recognized testing agency.
      h. Application of testing agency labels and seals.
      i. Notation of dimensions verified by field measurement
      j. Notation of coordination requirements.
      k. Availability and delivery time information.
      l. Rough-in diagrams and templates
      m. Mill reports.
      n. Standard product operating and maintenance manuals.
   4. For equipment, include the following in addition to the above, as applicable:
      a. Wiring diagrams that show factory-installed wiring.
      b. Printed performance curves.
      c. Operational range diagrams.
      d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
   5. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
C. Shop Drawings: Prepare project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect/Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products and materials.
   b. Schedules.
   c. Dimensions.
   d. Compliance with specified standards.
   e. Notation of coordination requirements.
   f. Notation of dimensions established by field measurement.
   g. Relationship and attachment to adjoining construction clearly indicated.
   h. Seal and signature of professional engineer if specified.

2. Shop Drawings include, but are not limited to, the following:
   a. Fabrication Drawings
   b. Installation Drawings
   c. Setting diagrams
   d. Shopwork manufacturing instructions
   e. Templates and patterns
   f. Schedules
   g. Design mix formulas

3. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches. These requirements also apply for PDF format of each submittal.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed. Submit samples physically identical with the material or product proposed for use; submit full-size, fully fabricated samples, cured and finished in the manner specified. Obtain written approval prior to submitting samples from Owner’s Designated Representative where color charts are acceptable for use as samples.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
   a. Project name and submittal number.
   b. Generic description of Sample.
   c. Product name and name of manufacturer.
   d. Sample source.
   e. Number and title of applicable Specification Section.
   f. Specification paragraph number and generic name of each item.
   g. Size limitations.
   h. Compliance with recognized standards.
   i. Compliance with governing regulations.
   j. Availability.
   k. Delivery time.

3. Samples include, but are not limited to the following types of submissions.
   a. Partial Sections of manufactured or fabricated components.
   b. Small cuts or containers of materials.
   c. Complete units of repetitively-used materials.
   d. Swatches showing color, texture and pattern.
   e. Color range sets.
   f. Components used for independent inspection and testing.
4. Web-Based Project Software: Prepare submittals in PDF form and provide a PDF transmittal with each submittal, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

5. 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. On the transmittal form, indicate such special requests regarding disposition of Sample submittals.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

6. Samples for Initial Selection: Where samples are specified for selection of color, pattern, texture or similar characteristics from a manufacturer's range of standard choices, submit a single, full set of available choices for the material or products. The use of manufacturer color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available in lieu of physical samples may be allowed with prior approval from the Owner's Designated Representative. Provide physical samples for items where color charts are not approved.
   a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect/Engineer will return submittal with options selected.

7. Samples for Verification: Submit full-size units or samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   a. Number of Samples: Submit three sets of Samples. Architect/Engineer and Owner’s Designated Representative will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
      3) If the Owner’s Designated Representative is in agreement with the use of electronic submittals, one set of samples is acceptable.

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 or assigned by Contractor if none is indicated.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.
   4. Location within room or space.
   5. Submit product schedule in the following format: PDF electronic file.

F. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified. Refer to 014000 “Quality Requirements” for additional requirements for qualification data and certificates.
G. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal. Refer to 014000 “Quality Requirements” for additional requirements for Delegated-Design Service submittals.

H. Certificates:
   1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer’s letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer’s letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer’s letterhead certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer’s letterhead certifying that product complies with requirements in the Contract Documents.
   7. Testing Agency Qualifications: Refer to section 014000 “Quality Requirements” for submittal requirements on qualifying testing agencies.

I. Test and Research Reports:
   1. Refer to section 014000 “Quality Requirements” for coordinating requirements submittals of test and research reports.
   2. 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.
   3. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   4. 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.
   5. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency’s standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
   6. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
   7. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
      a. Name of evaluation organization.
      b. Date of evaluation.
      c. Time period when report is in effect.
      d. Product and manufacturers' names.
1.8 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file 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.
   2. Refer to section 014000 “Quality Requirements” for coordinating submittal requirements on Delegated-Design submittals.

1.9 CONTRACTOR'S REVIEW

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

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project software. Include name of reviewer, date of Contractor’s approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   1. Owner's Designated Representative and Architect/Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT/ENGINEER'S REVIEW

A. Action Submittals: Architect/Engineer will review each submittal, indicate corrections or revisions required, and return it.
   1. PDF Submittals: Architect/Engineer will indicate, via markup on each submittal, the appropriate action.
      a. Action Stamp: The Owner’s Designated Representative, Architect/Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
         b. Final Unrestricted Release: Where submittals are marked "No Exception Taken," that part of the Work covered by the submittal may precede provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
         c. Final-But-Restricted Release: When submittals are marked "Make Correction as Noted," that part of the Work covered by the submittal may precede provided it complies with both the Owner Representative’s notations and corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
         d. Returned for Resubmittal: When submittal is marked "Revise and Resubmit", do not proceed with that part of the Work covered by the submittal; including purchasing, fabrication, delivery or other activity. Revise or prepare a new submittal in accordance with the Owner Representative’s notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
2. Submittals by Web-Based Project Software: Architect/Engineer will indicate, on Project software website, the appropriate action.

B. Informational Submittals: Architect/Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect/Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect/Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect/Engineer will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect/Engineer without action.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for quality assurance and quality control.
B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements, including testing and inspection, in individual Sections may also cover production of standard products as well as customized fabrication and installation procedures.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect/Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
   4. Specific test and inspection requirements are not specified in this Section.
C. Related Requirements:
   1. Section 013300 "Submittal Procedures" for administrative requirements governing the preparation and submittal required by this specification.
   2. Divisions 02 through 49 Sections for specific test and inspection requirements.

CRB Consulting Engineers, Inc.

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Quality Requirements
Rev. A, 03/16/17
Issue for Bid
1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction. Minimum years’ experience for individuals may also specified in their respective Specification Sections, the most stringent value shall prevail.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST’s National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by the Owner’s Designated Representative, Architect, or Engineer.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

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

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect/Engineer and Owner’s Designated Representative for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect/Engineer and Owner’s Designated Representative for a decision before proceeding.

1.6  ACTION SUBMITTALS

A. Shop Drawings: For laboratory mockups.
   1. Include plans, sections, and elevations, indicating materials and size of mockup construction.
   2. Indicate manufacturer and model number of individual components.
   3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7  INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Entity responsible for performing tests and inspections.
   3. Description of test and inspection.
   4. Identification of applicable standards.
   5. Identification of test and inspection methods.
   6. Number of tests and inspections required.
   7. Time schedule or time span for tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality control services include inspections and tests and related actions including reports, performed by independent agencies, governing authorities, or the Contractor. They do not include Contract enforcement activities performed by the Owner’s Designated Representative unless otherwise indicated.

B. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Owner’s Designated Representative and Architect/Engineer. 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.

C. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
   1. Project quality-control manager may also serve as Project superintendent.

D. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

E. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following: Refer to Divisions 02 through 49 Sections for specific test and inspection requirements.
   1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
   2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
   3. Owner-performed tests and inspections indicated in the Contract Documents.

F. 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.

G. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, telephone number, and email address of testing agency.
   4. Name, address, telephone number, and email address of Manufacturer's Technical Representative, or Factory-Authorized Service Representative.
   5. Dates and locations of samples and tests or inspections.
   6. Names of individuals making tests and inspections.
   7. Description of the Work and test and inspection method.
8. Identification of product and Specification Section.
9. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
10. Complete test or inspection data.
11. Test and inspection results and an interpretation of test results.
12. Record of temperature and weather conditions at time of sample taking and testing and inspection.
13. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
14. Name and signature of laboratory inspector.
15. Recommendations on retesting and re-inspecting.
16. Statement whether conditions, products, and installation will affect warranty.
17. Other required items indicated in individual Specification Sections.

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

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE
A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

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.

1. 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 inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

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. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:
   a. Provide test specimens representative of proposed products and construction.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
   e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
   f. When testing is complete, remove test specimens and test assemblies, mockups, and laboratory 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 Owner’s Designated Representative, Architect/Engineer, 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.
   a. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the State in which the Project is located.

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 of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Owner’s Designated Representative or Architect/Engineer.
3. Notify Owner’s Designated Representative and Architect/Engineer seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.

6. Obtain Owner’s Designated Representative and Architect/Engineer’s approval of mockups before starting corresponding work, fabrication, or construction.
   a. Allow seven days for initial review and each re-review of each mockup.

7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

8. Demolish and remove mockups when directed unless otherwise indicated.

L. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner’s responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
   2. Costs for these services are not included in the Contract Sum.
      a. The Owner will employ and pay for the services of an independent agency, testing laboratory or other qualified firm to perform services which are specified as the Owner’s responsibility.
   3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not. Costs for these services shall be included in the Contract Sum.
   2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
   4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Owner’s Designated Representative, Architect/Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Owner’s Designated Representative, Architect/Engineer, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Contractor to provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: The Contractor and each agency engaged to perform tests, inspections and similar services shall coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
   1. The Contractor is responsible for scheduling times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
   1. Distribution: Distribute schedule to Owner’s Designated Representative, Architect/Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Owner’s Designated Representative, Architect/Engineer, 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 Owner’s Designated Representative and Architect/Engineer with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG
A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Architect.
   4. Identification of testing agency or special inspector conducting test or inspection.
B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect/Engineer's reference during normal working hours.
   1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION
A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed 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 Section 017300 "Execution."
B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.
C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION
## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

### 1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if 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.
   1. 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: National Organizations of the U.S.” or in Columbia Books’ “National Trade & Professional Associations of the United States.”

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
   1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org
   2. ICC - International Code Council; www.iccsafe.org

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.
   2. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov
   3. DOE - Department of Energy; www.energy.gov
   4. EPA - Environmental Protection Agency; www.epa.gov
   5. FG - Federal Government Publications; www.gpo.gov/fdsys
   6. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov
   7. OSHA - Occupational Safety & Health Administration; www.osha.gov
   8. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov
   9. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
   1. USAB - United States Access Board; www.access-board.gov
   2. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
   1. TAS; Texas Accessibility Standards.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
SECTION 015000  TEMPORARY FACILITIES AND CONTROLS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:
   1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, architect/engineer, testing agencies, and authorities having jurisdiction.

B. 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.

C. 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 Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
   B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
   C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
   D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
   E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
      1. Locations of dust-control partitions.
      2. HVAC system isolation schematic drawing.
      3. Location of proposed air-filtration system discharge.
      5. Other dust-control measures.

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

1.6 PROJECT CONDITIONS
   A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner’s Designated Representative'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 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-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 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide concrete bases for supporting posts.
   C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
   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.
   1. Owner’s Designated Representative to determine if field offices will be allowed due to site constraints. Clarification will be given during pre-bid meeting and/or pre-construction meeting.

B. Common-Use Field Office (if allowed): Of sufficient size to accommodate needs of Owner’s Designated Representative, Architect/Engineer, 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 no fewer than one 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. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
   5. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

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’s Designated Representative 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 qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
   3. Permanent HVAC System: If Owner’s Designated Representative authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

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

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   1. Locate facilities to limit site disturbance as specified in 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.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
   1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service: Connect to Owner’s existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner’s Designated Representative. At Substantial Completion, restore these facilities to condition existing before initial use.

D. 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.
   1. Toilets: Use of Owner's existing toilet facilities will be permitted on the floor of the project site only, as long as facilities are cleaned and maintained in a condition acceptable to Owner’s Designated Representative. At Substantial Completion, restore these facilities to condition existing before initial use.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
   1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. 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 according to 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.

G. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner’s Designated Representative.

H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install Wi-Fi cell phone access equipment and one land-based telephone line(s) for each field office.
   1. At each telephone, post a list of important telephone numbers.
      a. Police and fire departments.
      b. Ambulance service.
      c. Contractor's home office.
      d. Contractor's emergency after-hours telephone number.
      e. Architect's office.
      f. Engineers' offices.
      g. Owner's Designated Representative's office.
      h. Principal subcontractors' field and home offices.
   2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

J. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
   1. Processor: Intel Core i5 or i7.
   2. Memory: 4 gigabyte.
   4. Display: 24-inch LCD monitor with 256-Mb dedicated video RAM.
   5. Full-size keyboard and mouse.
   8. Productivity Software:
      a. Microsoft Office Professional, 2010 or higher, including Word, Excel, and Outlook.
      b. Adobe Reader 11.0 or higher.
      c. WinZip 7.0 or higher.
   9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
   10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 1.0 Mbps upload and 15 Mbps download speeds at each computer.
   11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.

3.4 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 Architect/Engineer 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’s Designated Representative.

B. 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.

C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
D. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
   1. Identification Signs: Provide Project identification signs as indicated on Drawings.
   2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
      a. Provide temporary, directional signs for construction personnel and visitors.
   3. Maintain and touch up signs so they are legible at all times.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

F. 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.

G. Existing Elevator Use: Use of Owner's existing freight elevator at existing loading dock will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner's Designated Representative. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
   1. Do not load elevators beyond their rated weight capacity.
   2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

H. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner’s Designated Representative. At Substantial Completion, restore stairs to condition existing before initial use.
   1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
   1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property Owner’s Designated Representative to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with work restrictions specified in Section 011000 "Summary."

C. 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. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

D. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
   1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
   2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner’s Designated Representative.
E. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

G. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

H. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

I. 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-treated 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.

J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
   1. Prohibit smoking on University property.
   2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
   3. Develop and supervise an overall fire-prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
   4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
   1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
   2. Indicate sequencing of work that requires water, such as plastering, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
   3. Indicate methods to be used to avoid trapping water in finished work.
B. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
   1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
   2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
   3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
      a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
      b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect/Engineer.
      c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. 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’s Designated Representative 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 Section 017700 "Closeout Procedures."

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
1. Section 012300 "Alternates" for products selected under an alternate.
2. Section 012500 "Substitution Procedures" for requests for substitutions.

1.3 DEFINITIONS
A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Product: Product that is demonstrated and approved by Architect/Engineer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

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

1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect/Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Architect/Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."

b. Use product specified if Architect/Engineer does not issue a decision on use of a comparable product request within time allocated.


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. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect/Engineer will determine which products shall be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.

2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product and manufacturer.

b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:
1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner's Designated Representative.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."
PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner’s Designated Representative reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.


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.
   a. Submit additional documentation required by Architect/Engineer in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect/Engineer, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: …"

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: …"

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
   a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: …"

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
   a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: …"

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
   a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …"
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
   a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: …"

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect/Engineer's sample. Architect/Engineer's decision will be final on whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect/Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

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

B. Submittal Requirements: Approval by the Architect/Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (NOT USED)
**SECTION 017300**

**EXECUTION**

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**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:
   2. Installation of the Work.
   3. Cutting and patching.
   4. Coordination of Owner-installed products.
   5. Progress cleaning.
   6. Starting and adjusting.
   7. Protection of installed construction.

B. Related Requirements:
   1. Section 011000 "Summary" for limits on use of Project site.
   2. Section 013300 "Submittal Procedures."
   3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
   4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
   a. Contractor's superintendent.
   b. Trade supervisor responsible for cutting operations.
   c. Trade supervisor(s) responsible for patching of each type of substrate.
   d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.

3. Products: List products to be used for patching and firms or entities that will perform patching work.

4. Dates: Indicate when cutting and patching will be performed.

5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.6 QUALITY ASSURANCE

A. 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 Architect/Engineer of locations and details of cutting and await directions from Architect/Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. 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. Plumbing piping systems.
   f. Mechanical systems piping and ducts.
   g. Control systems.
   h. Communication systems.
   i. Fire-detection and -alarm systems.
   j. Conveying systems.
   k. Electrical wiring systems.
   l. 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, that results in reducing their capacity to perform as intended, or that results 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. Equipment supports.
   d. Piping, ductwork, vessels, and equipment.
   e. 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 Architect/Engineer’s opinion, reduce the building’s aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

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

1.7 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.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect/Engineer 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 sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.

2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.

2. List of detrimental conditions, including substrates.

3. List of unacceptable installation tolerances.

4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner’s Designated Representative 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 Contractor, submit a request for information to Architect/Engineer according to requirements in Section 013100 "Project Management and Coordination."
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 Architect/Engineer promptly.

B. General: 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 limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect/Engineer when deviations from required lines and levels exceed allowable tolerances.

C. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect/Engineer.

FIELD ENGINEERING

A. 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 Architect/Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect/Engineer before proceeding.

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. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect/Engineer.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.
   1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

K. 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. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. 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.

5. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. 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 rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 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's Designated Representative of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner's Designated Representative 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.

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
   a. Use containers intended for holding waste materials of type to be stored.

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 Section 015000 “Temporary Facilities and Controls.”

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

3.11 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.

B. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION
PART 1 - GENERAL

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

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

1.3 DEFINITIONS
A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
B. Special Warranties are written warranties required by or incorporated in the Contract Documents, to extend time limits provided either by standard warranties or to provide greater rights for the Owner.
1.4 ACTION SUBMITTALS
   A. Product Data: For each type of cleaning agent.
   B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
   C. Certified List of Incomplete Items: Final submittal at final completion.

1.5 CLOSEOUT SUBMITTALS
   A. Certificates of Release: From authorities having jurisdiction.
   B. Certificate of Insurance: For continuing coverage.
   C. Field Report: For pest control inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES
   A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
   B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
      1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
      2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, and similar final record information.
      3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
      4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner's Designated Representative. Label with manufacturer's name and model number.
         a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's Designated Representative's signature for receipt of submittals.
      5. Submit testing, adjusting, and balancing records.
      6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
   C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
      1. Advise Owner’s Designated Representative of pending insurance changeover requirements.
      2. Make final changeover of permanent locks and deliver keys to Owner’s Designated Representative. Advise Owner’s personnel of changeover in security provisions.
      3. Complete startup and testing of systems and equipment.
      4. Perform preventive maintenance on equipment used prior to Substantial Completion.
      5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."

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Issue for Bid
6. Advise Owner’s Designated Representative of changeover in utility services.
7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
8. Complete final cleaning requirements.
9. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer 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/Engineer, that must be completed or corrected before certificate will be issued.
   1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for final completion.

1.8 FINAL COMPLETION PROCEDURES
A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
   1. Submit a final Application for Payment according to Owner’s general conditions.
   2. Certified List of Incomplete Items: Submit certified copy of Architect/Engineer’s Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect/Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   4. Submit final completion photographic documentation.
   5. Instruct Owner’s personnel in operation, adjustment, and maintenance of products, equipment, and systems.
B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer 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. 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.

1.9 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 Architect.
   1. Organize list of spaces in sequential order.
   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/Engineer.
      d. Name of Contractor.
      e. Page number.
4. Submit list of incomplete items in the following format:

1.10 SUBMITTAL OF PROJECT WARRANTIES
   A. Time of Submittal: Submit written warranties on request of Architect/Engineer for designated portions of
      the Work where warranties are indicated to commence on dates other than date of Substantial
      Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
   B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated
      portions of the Work that are completed and occupied or used by Owner during construction period by
      separate agreement with Contractor.
   C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
   D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and
      bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each
      item. Provide bookmarked table of contents at beginning of document.
      1. Submit by uploading to web-based project software site.
   E. Warranties in Paper Form:
      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 8-1/2-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.
   F. Provide additional copies of each warranty to include in operation and maintenance manuals.

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 comply with Green Seal's 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 designated portion of Project:
         a. Clean Project site, yard, and grounds, in areas disturbed by construction activities,
            including landscape development areas, of rubbish, waste material, litter, and other foreign
            substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.
p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
q. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

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

END OF SECTION
SECTION 017823

OPERATION AND MAINTENANCE DATA

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory manuals.
   2. Emergency manuals.
   3. Systems and equipment operation manuals.
   4. Systems and equipment maintenance manuals.
   5. Product maintenance manuals.

B. Related Requirements:
   1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Architect/Engineer will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
B. Format: Submit operation and maintenance manuals in the following format:
1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit by uploading to web-based project software site with email notification to Architect/Engineer and Owner’s Designated Representative when upload is completed. Enable reviewer comments on draft submittals.
   a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
2. Submit one paper copy. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect/Engineer will return.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect/Engineer 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 15 days before commencing demonstration and training. Architect/Engineer will return copy with comments.
   1. Correct or revise each manual to comply with Architect/Engineer’s comments. Submit copies of each corrected manual within 15 days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation. Include transmittal with all deliveries to Owner. Request receipt confirmation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

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. 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: Bookmark individual documents based on 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 on opening file.

C. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered, post-type binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-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 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 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.


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.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: 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.

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 Architect/Engineer.
   7. Name and contact information for Commissioning Authority.
   8. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
   9. 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. 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, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
   1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

A. 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.

B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. 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.
5. Power failure.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. 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.

E. 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.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, 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 warranties and bonds as described below.

C. 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.
D. Manufacturers’ Maintenance Documentation: Include the following information for each component part or piece of equipment:
   1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
      a. Prepare supplementary text if manufacturers’ standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers’ forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers’ maintenance documentation and local sources of maintenance materials and related services.

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

I. 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.

J. Drawings: Prepare drawings supplementing manufacturers’ printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
SECTION 017839  PROJECT RECORD DOCUMENTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Requirements:
   1. Section 017300 "Execution" for final property survey.
   2. Section 017700 "Closeout Procedures" for general closeout procedures.
   3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit copies of record Drawings as follows:
      a. Initial Submittal:
         1) Submit one paper-copy set(s) of marked-up record prints.
         2) Submit PDF electronic files of scanned record prints and one file prints.
         3) Submit record digital data files and one set(s) of plots.
         4) Architect/Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
      b. Final Submittal:
         1) Submit PDF electronic files of scanned record prints and one set(s) of prints.
         2) Print each drawing, whether or not changes and additional information were recorded.
c. Final Submittal:
   1) Submit one paper-copy set(s) and PDF electronic files of marked-up record prints.
   2) Submit record digital data files and three set(s) of record digital data file plots.
   3) Plot each drawing file, whether or not changes and additional information were recorded.

B. Record Specifications: Submit one paper copy and annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one paper copy and annotated PDF electronic files and directories of each submittal.
   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: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy of each submittal.

E. Reports: Submit written report indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

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

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect/Engineer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file with comment function enabled.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Architect/Engineer for resolution.

C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect/Engineer 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/Engineer 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 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/Engineer.
   e. Name of Contractor.

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION
SECTION 017900  DEMONSTRATION AND TRAINING

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PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

1.2  SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. 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 using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For facilitator.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4  QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect/Engineer.

1.6 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Systems and equipment operation manuals.
   c. Systems and equipment maintenance manuals.
   d. Product maintenance manuals.
   e. Project Record Documents.
   f. Identification systems.
   g. Warranties and bonds.
   h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:
a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:
a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:
a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION
A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 “Operation and Maintenance Data.”

B. Set up instructional equipment at instruction location.

1.8 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’s Designated Representative with at least seven days’ advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION
SECTION 024119  
SELECTIVE DEMOLITION

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PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.
B. Related Requirements:
1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS
A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP
A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS
A. Pre-demolition 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 materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For refrigerant recovery technician.
B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
C. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.
   4. 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. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations.
E. 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.
F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS
A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE
A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
1.9 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 items as indicated on Drawings.
C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
E. Storage or sale of removed items or materials on-site is not permitted.
F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY
A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION
A. Arrange selective demolition schedule so as not to interfere with Owner’s operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings preconstruction photographs or video and templates.
   1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

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

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
   2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
   3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
   4. Cover and protect furniture, furnishings, and equipment that have not been removed.
   5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 1 requirements.
B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

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

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area designated by Owner.
   5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. 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 during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. 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. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section 070150.19 “Preparation for Re-Roofing” for roofing requirements at patching areas of existing roof.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   4. Comply with requirements specified in Division 1 requirements.

B. Burning: Do not burn demolished materials.

3.8 CLEANING

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

END OF SECTION
SECTION 033053  MISCELLANEOUS CAST-IN-PLACE CONCRETE

INDEX

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design,
      placement procedures, and finishes for housekeeping pads.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Design Mixtures: For each concrete mixture.

1.4 QUALITY ASSURANCE
   A. Ready-Mix-Concrete 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.

PART 2 - PRODUCTS

PART 3 - EXECUTION

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Miscellaneous Cast-in-Place Concrete
Rev. A, 03/16/17
Issue for Bid
PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL
A. Comply with the following sections of ACI 301 unless modified by requirements in the Contract Documents:
1. "General Requirements."
2. "Formwork and Formwork Accessories."
3. "Reinforcement and Reinforcement Supports."
4. "Concrete Mixtures."
5. "Handling, Placing, and Constructing."
B. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

2.2 FORMWORK
A. Furnish formwork and formwork accessories according to ACI 301.

2.3 STEEL REINFORCEMENT
A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
B. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 CONCRETE MATERIALS
A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
B. Cementitious Materials:
1. Portland Cement: ASTM C 150/C 150M, Type I/II, Type I, or Type III.
2. Fly Ash: ASTM C 618, Class C or F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
D. Air-Entraining Admixture: ASTM C 260/C 260M.
E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM 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.
F. Water: ASTM C 94/C 94M or ASTM C 1602/C 1602M.

2.5 CURING MATERIALS
A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
C. Water: Potable.
D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
2.6 CONCRETE MIXTURES
   A. Comply with ACI 301.
   B. Normal-Weight Concrete:
      1. Minimum Compressive Strength: 3000 psi at 28 days.
      2. Maximum W/C Ratio: 0.45.
      3. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 20 percent.
      4. Slump Limit: 5 inches, plus or minus 1 inch.
      5. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.7 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
      1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
   B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
      1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
      2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
      3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION
   A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEM INSTALLATION
   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.

3.3 STEEL REINFORCEMENT INSTALLATION
   A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 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.

3.5 CONCRETE PLACEMENT
   A. Comply with ACI 301 for placing concrete.
B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Do not add water to concrete during delivery, at Project site, or during placement.

D. Consolidate concrete with mechanical vibrating equipment according to ACI 301.

E. Equipment Bases and other miscellaneous interior concrete:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 3000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor them into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchor devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.6 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch.

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.

3.7 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab 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.

3.8 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 with ACI 301 for hot-weather protection during curing.

B. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

C. Curing Methods: Cure formed and unformed concrete for at least seven days 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.

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.

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.

3.9 **FIELD QUALITY CONTROL**

A. **Testing Agency**: Owner will engage a qualified testing agency to perform tests and inspections.

B. **Tests**: Perform according to ACI 301.

1. **Testing Frequency**: Obtain one composite sample for each day’s pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.

B. Related Sections:
1. Section 079200 “Joint Sealants” for sealing control and expansion joints in unit masonry.
2. Section 099123 “Interior Painting” for specialty coatings applied to exterior or interior faces of unit masonry assemblies.

1.3 DEFINITIONS
A. CMU(s): Concrete masonry unit(s).
B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS
A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 PRECONSTRUCTION TESTING
A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor’s expense.
1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Mortar Test (Proportion Specification per ACI-530): For each mix required, according to ASTM C 780 for compressive strength.
3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019 with proportioning specification ACI-530.

1.6 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For the following:
1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes. Show locations of bullnose units and square-edged units on outside corners.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars including all wall openings. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of all reinforced walls. Walls elevations shall be ¼” = 1'-0" scale as a minimum. Placing plans shall be coordinated with concrete rebar shop drawings with all masonry dowels included and detailed in concrete rebar shop drawings.

1.7 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.
B. Material Certificates: For each type and size of the following:
1. Masonry units.
   a. Include material test reports substantiating compliance with requirements.
   b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

E. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls.
C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.


PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL
   A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS
   A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
      1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
      2. Provide bullnose units for outside corners that will remain exposed unless otherwise indicated on Drawings. Provide square-edged units for outside corners concealed in other construction and as indicated on Drawings. Coordinate locations in Shop Drawings.
   B. CMUs: ASTM C 90.
      1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
      2. Density Classification: Normal weight unless otherwise indicated.
      3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
      4. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster,

2.3 CONCRETE AND MASONRY LINTELS
   A. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.
   B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 MORTAR AND GROUT MATERIALS
   A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
   1. Vertical Reinforcing: #5 Vertical at 48 inches on center.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Wire Size for Side Rods: 0.148-inch diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   2. Stainless-Steel Sheet: ASTM A 666, Type 304.
   3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.

C. Partition Top anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from PVC.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
   c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
   d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.8 **MORTAR AND GROUT MIXES**

A. **General:** Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. For reinforced masonry, use portland cement-lime mortar.
   4. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For reinforced masonry, use Type N.
   2. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
   3. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2,500 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

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**PART 3 - EXECUTION**

3.1 **EXAMINATION**

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION, GENERAL
A. Build chases and recesses to accommodate items specified in this and other Sections.
B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES
A. Dimensions and Locations of Elements:
1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS
A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Provide continuity at wall intersections by using prefabricated T-shaped units.

C. Provide continuity at corners by using prefabricated L-shaped units.

D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
1. Provide an open space not less than 2 inches wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 LINTELS
A. Provide concrete or masonry lintels where shown and where openings of more than 24 inches for block-size units are shown without structural steel or other supporting lintels.
B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 REINFORCED UNIT MASONRY INSTALLATION
A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.10 FIELD QUALITY CONTROL
A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site-prepared grout.
C. Testing Prior to Construction: One set of tests.
D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
3.11 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaneed for comparison purposes. Obtain Owner Representative's and Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION
### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section Includes:
1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Miscellaneous steel and stainless steel trim including stainless steel angle corner guards, stainless steel floor bumper rails, and stainless steel trim.
4. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:
1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

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C. Related Requirements:
   1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
   2. Section 042200 "Concrete Unit Masonry" for installing items built into unit masonry.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Paint products.
   2. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
   1. Steel framing and supports for mechanical and electrical equipment.
   2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
   3. Shelf angles.
   4. Miscellaneous steel and stainless steel trim including stainless steel angle corner guards, stainless steel floor bumper rails, and stainless steel trim.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316L.

D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 316L stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

G. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.3 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099123 “Interior Painting.”

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

C. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete: Comply with requirements in Section 033053 "Miscellaneous Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.
2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

I. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Prime miscellaneous steel framing and supports with zinc-rich primer where indicated. Do not prime or paint stainless steel unless otherwise indicated.

2.6 MISCELLANEOUS STEEL AND STAINLESS STEEL TRIM

A. General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled.

B. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
C. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

D. Stainless-Steel trim: Made from stainless-steel sheet Type 304, not less than 0.062-inch nominal thickness, with No. 4 satin finish.
   1. Detail as shown on Drawings.
   2. Weld shop-made joints.
   3. After fabricating and welding, grind surfaces smooth and polish as needed to produce uniform, directionally textured finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

E. Prime miscellaneous steel trim with primer specified in Section 099123 "Interior Painting." Do not prime or paint stainless steel unless otherwise indicated.

2.7 LOOSE BEARING AND LEVELING PLATES
A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
B. Prime steel plates with primer specified in Section 099123 "Interior Painting." Do not prime or paint stainless steel unless otherwise indicated.

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

2.9 STEEL AND IRON FINISHES
A. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with primers specified in Section 099123 "Interior Painting."
B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.10 STAINLESS STEEL FINISHES
A. Remove tool and die marks and stretch lines or blend into finish.
B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
C. Finishes:
   1. Bright, Directional Satin Finish: No. 4. Overall finishes to be consistent for use in a cleanroom. Vendor to notify cost saving alternatives, improvements or downgrades that still meet this objective and are visually appealing and cleanable. Surface finish #4 is appropriate.
D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
   A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
   B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
   C. Field Welding: Comply with the following requirements:
      1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      2. Obtain fusion without undercut or overlap.
      3. Remove welding flux immediately.
      4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
   E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS
   A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES
   B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with non-shrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING
   A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
   B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

END OF SECTION
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the understood roofing membrane system information for patching existing roofing system. Notify Owner’s Representative and Architect if Contractor field verified roof system differs from this specification:
   1. Built-up asphalt roofing used for patching.
   2. Roof insulation for roof patch.
1.3 MATERIALS OWNERSHIP
   A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain
      Owner's property, demolished materials shall become Contractor's property and shall be removed
      from Project site.

1.4 DEFINITIONS
   A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and
      Waterproofing Manual" for definition of terms related to built-up roofing.
   B. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.
   C. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or
      removal of selected components and accessories from existing membrane roofing system.
   D. Remove: Detach items from existing construction and legally dispose of them off-site unless
      indicated to be removed and reinstalled.
   E. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.5 PERFORMANCE REQUIREMENTS
   A. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift
      pressures, thermally induced movement, and exposure to weather without failure due to defective
      manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base
      flashings shall remain watertight.
   B. Material Compatibility: Provide roofing materials that are compatible with one another under
      conditions of service and application required, as demonstrated by built-up roofing manufacturer
      based on testing and field experience.
   C. Roofing Membrane Load-Strain Properties
      1. Provide a roofing membrane system consisting of the number of plies as the existing system
         or more that has been successfully tested by a qualified independent testing and inspecting
         agency to meet the following minimum load-strain properties at membrane failure when
         tested according to ASTM D 2523:
         a. Tensile strain at failure, at 0 deg F: 580 lbf machine direction, minimum.
         b. Tensile strain at failure, at 0 deg F: 470 lbf cross-machine direction, minimum.

1.6 ACTION SUBMITTALS
   A. Product Certificate: Submit notarized certificate, indicating complete list of products intended for use
      under Work of this Section, including product names and numbers and manufacturers’ names, with
      statement indicating that products to be provided meet the requirements of the Contract Documents.
   B. ASTM D2523 Certification: A certificate of successful achievement of ASTM standards specified
      (by a qualified and independent testing agency) for the proposed systems shall be submitted and
      approved by owner before materials may be released or installed. Certificate shall be stamped by a
      registered engineer.
   C. Product Data: For each type of product submitted as compatible materials to the existing roof
      system.
      1. Provide installation products, accessories and details documenting compatible tie into existing
         roof system.
D. **Shop Drawings:** For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
   1. Base flashings and built-up terminations.
   2. Tapered insulation, including slopes.
   3. Crickets, saddles, and tapered edge strips, including slopes.
   4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

E. **Samples for Verification:** For the following products:
   1. Built-up roofing materials, including base sheet, ply sheet, cap sheet, and flashing sheet, of color specified.

### 1.7 INFORMATIONAL SUBMITTALS

A. **Qualification Data:** For Installer including certificate that Installer is licensed to perform asbestos abatement.

B. **Manufacturer Certificates:** Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of compliance with performance requirements.

C. Field report on presence of hazardous materials, if applicable.

D. Fastener pull-out test report.

E. **Photographs or Videotape:** Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

F. **Landfill Records:** Indicate receipt and acceptance of hazardous wastes, such as asbestos-containing material, by a landfill facility licensed to accept hazardous wastes.

### 1.8 QUALITY ASSURANCE

A. **Installer Qualifications:** Installer of new membrane roofing system, licensed to perform asbestos abatement in the State or jurisdiction where Project is located and approved by Owner’s Representative existing roofing system to work on existing roofing.
   1. Owner’s Roofing Maintenance Contractor.

B. **Regulatory Requirements:** Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. **Reroofing Conference:** Conduct conference at Project site.
   1. Meet with Owner’s Representative; Architect; Owner’s insurer if applicable; testing and inspecting agency representative; roofing system manufacturer's representative; deck Installer; roofing Installer including project manager, superintendent, and foreman; and installers whose work interfaces with or affects reroofing including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing system tear-off and replacement including, but not limited to, the following:
      a. Reroofing preparation, including membrane roofing system manufacturer's written instructions.
      b. Temporary protection requirements for existing roofing system that is to remain during and after installation.
      c. Existing roof drains and roof drainage during each stage of reroofing, and roof drain plugging and plug removal requirements.
      d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
      e. Existing deck removal procedures and Owner notifications.
f. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
g. Structural loading limitations of deck during reroofing.
h. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect reroofing.
i. HVAC shutdown and sealing of air intakes.
j. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
k. Asbestos removal and discovery of asbestos-containing materials.
l. Governing regulations and requirements for insurance and certificates if applicable.
m. Existing conditions that may require notification of Owner’s Representative and Architect before proceeding.

1.9 PROJECT CONDITIONS
A. Existing Membrane Roofing System: Available information on the existing roof is consistent with a ballasted built-up hot asphalt modified bituminous roofing membrane, roof insulation, surfacing, and components and accessories between deck and roofing membrane. Contractor shall confirm existing roof system components, installation type, number of layers, and types of materials. Provide written documentation of existing system for verification of compatible new materials to be used.
B. Hazardous Materials: The approximate age of the existing roof is consistent with hazardous materials being present in areas of roof patching. Contractor to confirm if existing materials contain asbestos and coordinate with hazardous material remediation subcontractor to prevent water from entering existing roofing system or building.
   1. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.
C. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations will not be disrupted. Provide Owner’s Representative with not less than 72 hours’ notice of activities that may affect Owner's operations.
   1. Coordinate work activities daily with Owner’s Representative so Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area.
D. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
E. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
F. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
G. Limit construction loads on roof to rooftop equipment wheel loads and refer to existing structural drawings for uniformly distributed loads. In the absence of drawings and/or historical data on existing roof conditions, contractor shall consult with a structural engineer for evaluation of existing conditions.
H. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1.10 DELIVERY, STORAGE, AND HANDLING
A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

PART 2 - PRODUCTS

2.1 INFILL MATERIALS

A. Use infill materials matching existing membrane roofing system materials unless a matching component is no longer available.
   1. Provide new materials consistent and compatible with existing roofing system.

2.2 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are responsibilities of Contractor, if required by roof patching scope. If roof patching work can be completed the day the roof is opened up, temporary roofing may not be required.

B. Sheathing Paper: Red-resin type, minimum 3 lb/100 sq. ft.

C. Base Sheet: ASTM D 4601, Type II, non-perforated, asphalt-impregnated and -coated, glass-fiber sheet.

D. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.

E. Asphalt Primer: ASTM D 41.

F. Roofing Asphalt: ASTM D 312, Type III or IV.

2.3 AUXILIARY REROOFING MATERIALS

A. General: Auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of new membrane roofing system.

2.4 BALLAST

A. Aggregate Ballast: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:
   1. Size: ASTM D 448, Size to match existing size range.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.

B. Protect existing membrane roofing system that is indicated not to be reroofed.
   1. Loosely lay 1-inch- minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch.
2. Limit traffic and material storage to areas of existing roofing membrane that have been protected.

3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

C. Coordinate with Owner’s Representative to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

D. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

E. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.

F. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

3.2 ROOF TEAR-OFF FOR PATCHING

A. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing using a power broom.

B. Remove aggregate ballast from roofing. Store aggregate ballast for reuse.

C. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse. Discard cracked pavers.

D. Remove protection mat and extruded-polystyrene insulation from protected roofing membrane.

1. Discard extruded-polystyrene insulation that is wet and exceeds 8 lb/cu. ft.

2. Store extruded-polystyrene insulation for reuse and protect from physical damage.

E. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.

1. Remove present cover boards, roof insulation and substrate boards.

2. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove un-adhered bitumen and felts and wet felts.

3. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.

4. Remove fasteners from deck or cut fasteners off slightly above deck surface.

5. Remove existing roofing membrane and immediately check for presence of moisture by visually observing materials that will remain.

6. Coordinate with Owner's inspector to schedule times for tests and inspections immediately after membrane removal.

7. With an electrical capacitance moisture-detection meter, spot check cover boards, roof insulation, substrate boards that will remain.

8. Remove wet or damp boards and roof insulation.

3.3 DECK PREPARATION

A. Inspect deck after partial tear-off of membrane roofing system.
B. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint of hot roofing asphalt on deck at start of each day’s work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.

C. If broken or loose fasteners that secure deck panels to one another or to structure are observed or if deck appears or feels inadequately attached, immediately notify Owner’s Representative and Architect. Do not proceed with installation until directed by Owner’s Representative and Architect.

D. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Owner’s Representative and Architect. Do not proceed with installation until directed by Owner’s Representative and Architect.

E. Provide additional deck securement as indicated on Drawings.

F. Replace deck as indicated on Drawings.

3.4 ROOF RE-COVER PREPARATION

A. Remove blisters, ridges, buckles, and other substrate irregularities from existing roofing membrane that inhibit new recover boards from conforming to substrate.
   1. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   2. Scarify the surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards.
   3. Broom clean existing substrate.
   4. Coordinate with Owner’s inspector to schedule times for tests and inspections before proceeding with installation of recover boards.
   5. Verify that existing substrate is dry before proceeding with installation of recover boards. Spot check substrates with an electrical capacitance moisture-detection meter.
   6. Remove materials that are wet or damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.

B. Remove blisters and areas of membrane not fully adhered.

3.5 INFILL MATERIALS INSTALLATION

A. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
   1. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

3.6 INSULATION INSTALLATION

A. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.

B. Wood Fiber Cant Strips: Install and secure preformed 45-degree insulation can’t strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
   1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

E. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
F. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

3.7 BUILT-UP ROOFING INSTALLATION, GENERAL
A. Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
B. Start installation of built-up roofing in presence of manufacturer's technical personnel.
C. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   1. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
   3. Remove and discard temporary seals before beginning work on adjoining roofing.
D. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
E. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.
G. Aggregate Ballast: Apply uniformly over roofing at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roofing is installed, leaving roofing ballasted at the end of the workday.

3.8 EXISTING BASE FLASHINGS
A. Remove existing base flashings around curbs and penetrations. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish.

3.9 PROTECTING AND CLEANING
A. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner’s Representative.
B. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
3.10 DISPOSAL

A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
   1. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off Owner's property.

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.

### 1.3 ACTION SUBMITTALS

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

B. Product Schedule: For each penetration firestopping system. Include location 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. Obtain approval of authorities having jurisdiction prior to submittal.
1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer’s written recommendations.
C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors,” or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements.”
B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping” Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:
      1) UL in its "Fire Resistance Directory."
C. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
B. Install and cure penetration firestopping per manufacturer’s written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION
A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Grace Construction Products.
   2. Hilti, Inc.
   3. 3M Fire Protection Products.
   5. USG Corporation.
2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Fire-resistance-rated walls include fire-barrier walls.
   2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

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 manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
   1. Permanent forming/damming/backing materials, including the following:
      a. Slag-wool-fiber or rock-wool-fiber insulation.
      b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
      c. Fire-rated form board.
      d. Fillers for sealants.
   2. Temporary forming materials.
   5. Steel sleeves.

2.3 FILL MATERIALS

A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

D. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

F. 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.
G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping 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.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: 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.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping 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 fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 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 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 is 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 and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
B. Firestopping with No Penetrating Items FS-1:
   2. F-Rating: Match rating of surrounding construction.
   4. W-Rating: No leakage of water at completion of water leakage testing.
   5. Type of Fill Materials: As required to achieve rating.

C. Firestopping for Metallic Pipes, Conduit, or Tubing FS-2:
   2. F-Rating: Match rating of surrounding construction.
   4. W-Rating: No leakage of water at completion of water leakage testing.
   5. Type of Fill Materials: As required to achieve rating.

G. Firestopping for Insulated Pipes FS-3:
   2. F-Rating: Match rating of surrounding construction.
   4. W-Rating: No leakage of water at completion of water leakage testing.
   5. Type of Fill Materials: As required to achieve rating.

H. Firestopping for Miscellaneous Electrical Penetrants FS-4:
   2. F-Rating: Match rating of surrounding construction.
   4. W-Rating: No leakage of water at completion of water leakage testing.
   5. Type of Fill Materials: As required to achieve rating.

I. Firestopping for Miscellaneous Mechanical Penetrants FS-5:
   2. F-Rating: Match rating of surrounding construction.
   4. W-Rating: No leakage of water at completion of water leakage testing.
   5. Type of Fill Materials: As required to achieve rating.

END OF SECTION
SECTION 079200  JOINT SEALANTS

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PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

1.2  SUMMARY

A. Section Includes:
  1. Silicone joint sealants.
  2. Urethane joint sealants.
  3. Acoustical joint sealants.

B. Related Sections:
  1. Section 088000 "Glazing" for glazing sealants.
  2. Section 092900 "Gypsum Board" for sealing perimeter joints.
  3. Section 095113 "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with acoustical sealant.
1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 or manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
   2. Conduct field tests for each application indicated below:
      a. Each kind of sealant and joint substrate indicated.
   3. Notify Architect and Owner’s Representative seven days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
         1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind 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.

C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer and testing agency.
   B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
   C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
   D. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
      1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
      2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
   E. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
   F. Field-Adhesion Test Reports: For each sealant application tested.
   G. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE
   A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
   C. Product Testing: Test joint sealants using a qualified testing agency.
      1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
   D. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT 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.

1.8 WARRANTY
   A. Special Installer's Warranty: Manufacturer's standard form in which 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's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those 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.
C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, 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. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1. Architectural Sealants: 250 g/L.
      2. Sealant Primers for Nonporous Substrates: 250 g/L.
      3. Sealant Primers for Porous Substrates: 775 g/L.
   C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
   E. Colors of Exposed Joint Sealants: As selected by Owner’s Representative from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS
   A. Silicone, Non-staining, S, NS, 100/50, NT: Non-staining, single-component, non-sag, plus 100 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT. (SS-1)
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
         a. Pecora Corporation; Pecora 890FTS/TXTR.
         b. Tremco Incorporated; Spectrem 1.
   B. Silicone, Non-staining, S, NS, 50, NT: Non-staining, single-component, non-sag, plus 50 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT. (SS-2)
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
         a. Dow Corning Corporation; Dow Corning® 795 Silicone Building Sealant.
         b. GE Construction Sealants; Momentive Performance Materials Inc.; Silpruf NB.
         c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 295 FPS NB.
         d. Pecora Corporation; Pecora 895NST.
         e. Tremco Incorporated; Spectrem 3.
C. Silicone, Non-staining, S, NS, 100/50, T, NT: Non-staining, single-component, non-sag, plus 100 percent and minus 50 percent movement capability, traffic- and non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT. (SS-3)  
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:  
   a. Dow Corning Corporation; Dow Corning® 790 Silicone Building Sealant.  
   b. Approved Equals.

2.3 **MILDEW-RESISTANT JOINT SEALANTS**
   
   A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
   
   B. Mildew-Resistant, Non-staining, Single-Component, Non-sag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT. (for interior joints at fixtures, etc.) (SS-4)  
   1. **Products:** Subject to compliance with requirements, provide one of the following:  
      a. Pecora Corporation; 898 NST  
      b. Equal Products by other manufacturers.

2.4 **URETHANE JOINT SEALANTS**
   
   A. Urethane, S, NS, 25, T, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Uses T and NT. (US-1).

2.5 **LATEX JOINT SEALANTS**
   
   A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF. (LS-1)

2.6 **ACOUSTICAL JOINT SEALANTS**
   
   A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. (AS-1)  
   1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:  
      a. Pecora Corporation; AC-20 FTR.  
      c. USG Corporation; SHEETROCK Acoustical Sealant.

   2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 **JOINT SEALANT BACKING**
   
   A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   
   B. Cylindrical Sealant Backings: ASTM C 1330, 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.
2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
   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.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
3.3  INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of 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 per Figure 8A in ASTM C 1193, unless otherwise indicated.
   4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
   5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4  FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
      a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   3. Inspect tested joints and report on the following:
      a. Whether sealants filled joint cavities and are free of voids.
      b. Whether sealant dimensions and configurations comply with specified requirements.
c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer’s field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING
A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION
A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE
A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces SS-3
1. Joint Locations:
   a. Joints between metal panels.
   b. Joints at roof penetrations.
   c. Joints between different materials listed above.
   d. Other joints as indicated.
2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50.
3. Joint-Sealant Color: As selected by Owner’s Representative from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces SS-3 or US-1.
1. Joint Locations:
   b. Other joints as indicated.
2. Urethane or Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing compatible with floor coatings.
3. Joint-Sealant Color: As selected by Owner’s Representative from manufacturer's full range of colors.
C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces SS-1 or SS-2.
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of walls.
      b. Perimeter joints of openings where indicated.
      c. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
      d. Perimeter joints between interior wall surfaces and frames of interior doors or windows.
      e. At edges and joints of wall protection.
      f. Other joints as indicated.
   2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50 or Class 50.
   3. Joint-Sealant Color: As selected by Owner’s Representative from manufacturer's full range of colors.

   1. Joint Sealant Location:
      a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      b. Other joints as indicated.
   2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
   3. Joint-Sealant Color: As selected by Owner’s Representative from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces not subject to significant movement LS-1.
   1. Joint Locations in non-GMP spaces:
      a. Control joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
      c. Other joints as indicated on Drawings.
   3. Joint-Sealant Color: As selected by Owner’s Representative and Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal non-traffic surfaces AS-1.
   1. Joint Location:
      a. Acoustical joints where indicated.
      b. Other joints as indicated.

END OF SECTION
SECTION 081113  HOLLOW METAL DOORS AND FRAMES

INDEX

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes interior hollow-metal work.
B. Related Requirements:
1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
2. Section 099123 "Interior Painting" for field painting hollow metal doors and frames.
3. Division 16 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS
A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.
B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Project Conditions: Verify actual dimensions of openings by field measurements before fabrication.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings, removable stops, and glazing.
   9. Details of conduit and preparations for power, signal, and control systems.

C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ceco Door Products; an Assa Abloy Group company.
   2. Curries Company; an Assa Abloy Group company. (Basis-of-Design)
   4. Steelcraft; an Ingersoll-Rand company.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
   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.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

   1. Physical Performance: Level A according to SDI A250.4.
   2. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      c. Face: Uncoated or Metallic-coated where indicated, cold-rolled steel sheet, minimum thickness of 0.053 inch.
      d. Edge Construction: Model 2, Seamless. All seams are to be welded and ground smooth to give a seamless and monolithic appearance at all edges of doors.
      e. Vertical Edges for Single-Acting Doors: Beveled edge.
      f. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end channels with filler caps of same material as face sheets. There should be no pockets or hollows on ends of doors. All seams are to be welded and ground smooth to give a seamless and monolithic appearance at all edges of doors.
         1) Omit filler cap at bottom edge of doors when recessed door sweeps are indicated.
      g. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, or polyisocyanurate core.
   3. Frames:
      a. Materials: Uncoated or Metallic-coated where indicated, steel sheet, minimum thickness of 0.053 inch.
      b. Construction: Full profile welded.
2.4 HOLLOW-METAL PANELS
A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.5 FRAME ANCHORS
A. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 MATERIALS
A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
I. Glazing: Comply with requirements in Section 088000 "Glazing."
J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION
A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
B. Hollow-Metal Doors:
   1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
   3. Top and Bottom Edges: Closed with flush or inverted 0.053-inch-thick, end channels with filler caps of same material as face sheets. There should be no pockets or hollows on ends of doors. All seams are to be welded and ground smooth to give a seamless and monolithic appearance at all edges of doors.
      a. Omit filler cap at bottom edge of doors when recessed door sweeps are indicated.
   4. 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.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   1. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor.
   5. Jamb Anchors: Provide number and spacing of anchors as follows:
      a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
         1) Two anchors per jamb up to 60 inches high.
         2) Three anchors per jamb from 60 to 90 inches high.
         3) Four anchors per jamb from 90 to 120 inches high.
         4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
      b. Post-installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
   6. 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.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
   2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed. Moldings to be sloped at 45 degree angle from face of door to face of glazing, on both sides of door.
2. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
3. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
4. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
5. Provide loose stops and moldings on inside of hollow-metal work.
6. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES
A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES
A. Mullions: Join to adjacent members by welding.
B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION
A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
b. Install frames with removable stops located on secure side of opening.
c. Install door silencers in frames before grouting.
d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, 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 hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Steel Doors:
      a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
      c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
      d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.
   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION
SECTION 083113

INDEX

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.

D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

2.2 MATERIALS

2.3 FABRICATION

2.4 FINISHES

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION

3.3 ADJUSTING
PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Flush Access Doors with Exposed Flanges:
   1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Acudor Products, Inc.
      b. JL Industries, Inc.; a division of the Activar Construction Products Group.
      c. MIFAB, Inc.
      d. Milcor; Commercial Products Group of Hart & Cooley, Inc.
      e. Nystrom, Inc.
   2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
   3. Locations: Wall and ceiling.
   4. Door Size: As indicated on Drawings.
   5. Stainless-Steel Sheet for Door: Nominal 0.062 inch, 16 gage. Finish: No. 4.
   6. Frame Material: Same material, thickness, and finish as door.
   8. Latch and Lock: Cam latch, screwdriver operated.
      a. Gasketing only required at process spaces.

2.2 MATERIALS

A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
B. Frame Anchors: Same type as door face.
C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. Provide mounting holes in frames for attachment of units to metal framing.
D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Comply with manufacturer's written instructions for installing access doors and frames.
B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING
A. Adjust doors and hardware, after installation, for proper operation.
B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION
SECTION 087100  DOOR HARDWARE

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PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes:
      1. Mechanical door hardware for the following:
         a. Swinging doors.
      2. Cylinders for door hardware specified in other Sections.
B. Related Sections:
   1. Hollow Metal Doors & Frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:
   1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. 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.
      b. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
      c. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
      d. Content: Include the following information:
         1) Identification number, location, hand, fire rating, size, and material of each door and frame.
         2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
         3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
         4) Fastenings and other pertinent information.
         5) Explanation of abbreviations, symbols, and codes contained in schedule.
         6) Mounting locations for door hardware.
         7) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Architectural Hardware Consultant.

B. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.6 QUALITY ASSURANCE

A. 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 follows:
   1. For door hardware, an Architectural Hardware Consultant (AHC).

B. Source Limitations: Obtain each type of door hardware from a single manufacturer.
C. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

D. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

E. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

F. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and the 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.
   2. Comply with the following maximum opening-force requirements:
      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
      b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
   4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

G. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination". Within 30 days after execution of the contract, the Contractor shall initiate a keying conference between the Hardware Contractor, representatives of Facilities Operations and Design and Construction Management, and representatives of the occupants of the building.

1.7 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. Hardware Delivery Confirmation: As soon as hardware is ordered, the Hardware Contractor shall send to the Department of Facilities Operations the factory order number and the factory shipping date.

D. Deliver keys directly to the Owner before Substantial Completion of the project. Keys shall be sent via certified mail or personal delivery. Refer to Division One for criteria regarding temporary keys for access to existing spaces.

1.8 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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.
   a. Exit Devices: Two years from date of Substantial Completion.
   b. Manual Closers: 10 years from date of Substantial Completion.

1.10 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, provide six 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. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
   1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
   2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

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

2.3 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.

C. Lock Backset: 2-3/4 inches, unless otherwise indicated.

D. Lock Trim:
   1. Operating Device: Lever with escutcheons (roses).

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.
F. Bored Locks: BHMA A156.2; Series 4000 Grade 1 or BHMA A156.2 Series 4000 Grade 2 as listed on the hardware schedule.
   1. Manufacturers:
      a. Best – 9K – No Substitution

2.4 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.
   1. Manufacturers:
      a. Von Duprin – No Substitution

2.5 LOCK CYLINDERS

A. Lock Cylinders: Small Format Interchangeable core, 7 pin type, constructed from brass or bronze, stainless steel, or nickel silver.
   1. Manufacturers:
      a. Best – No Substitution

2.6 KEYING

   1. Key to Owner’s existing 7-pin SFIC Key System. Provide construction keying.
      a. Master key or grand master key locks to Owner's requirements.
   B. Keys: Brass.
      1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
          a. Notation: "DO NOT DUPLICATE."
      2. Quantity: In addition to one extra key blank for each lock, provide the following:
          b. Master Keys: Six.
          c. Construction Key: Five

2.7 OPERATING TRIM

A. Operating Trim: BHMA A156.6; as indicated.
   1. Manufacturers:
      a. Ives.

2.8 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. Astragals: BHMA A156.22.
      1. Manufacturers:
         a. Ives.

2.9 SURFACE CLOSERS AND ADA OPERATORS

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 recommendations 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. Manufacturers:
      a. LCN – No Substitution
2. All Closers UL Certified to be in compliance with UBC 7.2 and UL 10C.
3. Closers with pressure relief values will not be acceptable.
4. Supplier to provide any brackets or plates required for proper installation of door closers.
5. Provide closers at all doors.

B. ADA Operators: Ref: Section 0987113

2.10 THRESHOLDS
A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
   1. Manufacturers:
      a. Zero
      b. National Guard
      c. Reese

2.11 METAL PROTECTIVE TRIM UNITS
A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ives

2.12 AUXILIARY DOOR HARDWARE
A. Auxiliary Hardware: BHMA A156.16.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ives

2.13 ELECTRIC STRIKES
A. Manufacturers:
   1. Von Duprin – No Substitution
B. Requirements:
   1. Provide electric strikes designed for use with the type locks shown at each opening.
   2. Provide electric strikes UL Listed as burglary-resistant electric door strikes and where required shall be UL Listed as electric strikes for fire doors and frames. Provide fail-secure type electric strikes, unless specified otherwise.
   3. Provide transformers and rectifiers for each strike as required. Verify voltage with electrical contractor.

2.14 MAGNETIC LOCKS
A. BHMA: A156.23; Meets or exceeds 1500 lbs holding force.
   1. Manufacturers:
      a. Schlage Electronics – No Substitution

2.15 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-rated 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.

2.16 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

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

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.


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. 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. Thresholds: Set thresholds for doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

E. 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.

F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

G. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 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.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, hardware supplier’s representative 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.

3.5 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.

3.6 DOOR HARDWARE SCHEDULE

A. The hardware sets listed below represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process.
HARDWARE GROUP NO. 01

FOR USE ON MARK/DOOR #S:
000B 5C6AA

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HARDWARE GROUP NO. 02

FOR USE ON MARK/DOOR #S:
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HARDWARE GROUP NO. 03

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NOTE: CARD READER, POWER SUPPLY AND BALANCE OF ACCESS CONTROL COMPONENTS TO BE PROVIDED BY SECTION 281300 CONTRACTOR.

SEQUENCE OF OPERATION: DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL ALLOWS ENTRY. FREE EGRESS PERMITTED AT ALL TIMES.

HARDWARE GROUP NO. 04

FOR USE ON MARK/DOOR #(#S):
548A        549A

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NOTE: BALANCE OF HARDWARE IS EXISTING AND TO BE RE-USED. FIELD VERIFY NEW HARDWARE WILL WORK WITH EXISTING DOOR/FRAME PREPS AND RE-WORK AS REQUIRED.

NOTE: CARD READER, POWER SUPPLY AND BALANCE OF ACCESS CONTROL COMPONENTS TO BE PROVIDED BY SECTION 281300 CONTRACTOR.

SEQUENCE OF OPERATION: DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL ALLOWS ENTRY. FREE EGRESS PERMITTED AT ALL TIMES.

HARDWARE GROUP NO. 05

FOR USE ON MARK/DOOR #(#S):
547A        547AA        548B        547C        564AA

EACH TO HAVE:

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**NOTE:** NO WORK - EXISTING TO REMAIN.

## HARDWARE GROUP NO. 07

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## HARDWARE GROUP NO. 08

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HARDWARE GROUP NO. 09

FOR USE ON MARK/DOOR #(S):
567A  569A  572A

EACH TO HAVE:

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NOTE: CARD READER, POWER SUPPLY AND BALANCE OF ACCESS CONTROL COMPONENTS TO BE PROVIDED BY SECTION 281300 CONTRACTOR.

SEQUENCE OF OPERATION: DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL ALLOWS ENTRY. FREE EGRESS PERMITTED AT ALL TIMES (MOTION SENSOR OR PUSH-TO-EXIT BUTTON).

HARDWARE GROUP NO. 10

FOR USE ON MARK/DOOR #(S):
574A  575A  577A  578A  579A  582A
583A  584A

EACH TO HAVE:

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NOTE: BALANCE OF HARDWARE IS EXISTING AND TO BE RE-USED.

NOTE: CARD READER, POWER SUPPLY AND BALANCE OF ACCESS CONTROL COMPONENTS TO BE PROVIDED BY SECTION 281300 CONTRACTOR.

SEQUENCE OF OPERATION: DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL ALLOWS ENTRY. FREE EGRESS PERMITTED AT ALL TIMES (MOTION SENSOR OR PUSH-TO-EXIT BUTTON).
HARDWARE GROUP NO. 11

FOR USE ON MARK/DOOR #(#S):

580B

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HARDWARE GROUP NO. 12

FOR USE ON MARK/DOOR #(#S):

5C7AA

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</table>

SEQUENCE OF OPERATION: Doors are interlocked with 5C7BB. Doors normally in unlocked position unless any leaf of door 5C7BB is open. Auto operator on active leaf functions as long as both leaves of door 5C7BB are in the closed position. Push-to-exit button is for emergency egress. Mag locks to be tied into the fire alarm system to release upon activation of fire alarm or loss of power.
# HARDWARE GROUP NO. 13

FOR USE ON MARK/DOOR #(S):
5C7BB

EACH TO HAVE:

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</table>

NOTE: CARD READER, POWER SUPPLY AND BALANCE OF ACCESS CONTROL COMPONENTS TO BE PROVIDED BY SECTION 281300 CONTRACTOR.

SEQUENCE OF OPERATION: DOORS ARE INTERLOCKED WITH 5C7AA. DOORS NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL RETRACTS LATCHBOLT ON ACTIVE LEAF AND ALLOWS ENTRY AS LONG BOTH LEAVES OF DOOR 5C7AA ARE IN THE CLOSED POSITION. AUTO OPERATOR FUNCTIONS AFTER VALID CREDENTIAL READ AS LONG AS BOTH LEAVES OF DOOR 5C7AA ARE IN THE CLOSED POSITION. PUSH-TO-EXIT BUTTON IS FOR EMERGENCY EGRESS. MAG LOCKS TO BE TIED INTO THE FIRE ALARM SYSTEM TO RELEASE UPON ACTIVATION OF FIRE ALARM OR LOSS OF POWER.

# HARDWARE GROUP NO. 14

FOR USE ON MARK/DOOR #(S):
5C9A

EACH TO HAVE:

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<th>QTY</th>
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HARDWARE GROUP NO. 15

FOR USE ON MARK/DOOR #(#S):
5C10A      5C11B

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HARDWARE GROUP NO. 16

FOR USE ON MARK/DOOR #(#S):
5C10B      5C11A

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<td>@ 5C10B ONLY</td>
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SEQUENCE OF OPERATION: DELAYED EGRESS. PUSHING ON EXIT DEVICE SOUNDS ALARM AND BEGINS AN IRREVERSIBLE COUNTDOWN WITH DOOR OPENING AFTER 15 SECONDS. NO ENTRY FROM PULL SIDE.

END OF SECTION
# AUTOMATIC DOOR OPERATORS

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## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:
   1. Power door operators for swinging doors.

### 1.3 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
For automatic door terminology, see BHMA A156.10 and BHMA A156.19 for definitions of terms.

1.4 COORDINATION
A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.
B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
C. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to power supplies and access-control system.

1.5 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For automatic door operators.
   1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
   2. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
   3. Indicate locations of activation and safety devices.
   4. Include diagrams for power, signal, and control wiring.

1.7 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer and Certified Inspector.
B. Product Certificates: For each type of automatic door operator. For each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.
C. Field quality-control reports.
D. Sample Warranties: For manufacturer's special warranties.

1.8 CLOSEOUT SUBMITTALS
A. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.

1.9 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project and who employs a Certified Inspector.
   1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
B. Certified Inspector Qualifications: Certified by AAADM.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

D. Exit-Door Requirements: Comply with requirements of authorities having jurisdiction for doors with automatic door operators serving as a component of a required means of egress.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Faulty or sporadic operation of automatic door operator, including controls.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
2. Warranty Period: Three years mechanical and 1 year electrical from date of Substantial Completion.

1.11 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of door frames by field measurements before fabrication of exposed covers for automatic door operators.

1.12 COORDINATION

A. Templates: Obtain and distribute, to the parties involved, templates for doors, frames, operators, and other work specified to be factory prepared and reinforced for installing automatic door operators. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic door operators to comply with indicated requirements.

B. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators, including activation and safety devices, with connections to power supplies and to access-control system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Detex Corporation’s AO19 series or comparable product by one of the following:
   1. Besam Entrance Solutions; ASSA ABLOY.
   2. Horton Automatics; a division of Overhead Door Corporation.
   3. LCN; an Allegion brand.
   4. SARGENT Manufacturing Company; ASSA ABLOY.

B. Source Limitations: Obtain automatic door operators, including activation and safety devices, from single source from single manufacturer.

2.2 AUTOMATIC DOOR OPERATORS, GENERAL

A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and according to UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.

C. Hinges: See Section 087100 "Door Hardware" for hinge type for each door that door operator shall accommodate.

D. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch-thick, extruded or formed aluminum; continuous over full width of operator-controlled door opening; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

E. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 LOW-ENERGY DOOR OPERATORS

A. Standard: BHMA A156.19.

B. Performance Requirements:
   1. Opening Force if Power Fails: Not more than 15 lbf required to release latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
   2. Entrapment-Prevention Force: Not more than 15 lbf required to prevent stopped door from closing or opening.

C. Configuration: Operator to control single swinging door.
   1. Traffic Pattern: Two way.
   2. Operator Mounting: Surface.

D. Configuration: Operator to control pair of swinging doors.
   1. Traffic Pattern: Two way.

E. Operation: Power opening and spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.

F. Operating System: Electromechanical.

G. Microprocessor Control Unit: Solid-state controller.

H. Features:
   1. Adjustable opening and closing speed.
   2. Adjustable opening and closing force.
   3. Adjustable backcheck.
   4. Adjustable hold-open time from zero to 30 seconds.
   5. Adjustable time delay.
   6. Adjustable acceleration.
   7. Obstruction recycle.
   8. On-off/hold-open switch to control electric power to operator; key operated.

I. Activation Device: Motion (hand-wave) sensor switch wall mounted to activate door operator.

J. Exposed Finish: Class II, clear anodic finish.
2.4 MATERIALS
   A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      1. Extrusions: ASTM B 221.
   B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness, in manufacturer's standard thickness.
   C. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.
   D. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.5 CONTROLS
   A. General: Provide controls, including activation and safety devices, according to BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
   B. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed in plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
      1. Provide capability for switching between bidirectional and unidirectional detection.
      2. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
   C. Combination Card Reader/Hand-wave Proximity Switch: Door control switch with card reader and/or hand-wave proximity reader actuator.
      1. Mounting: As indicated on Drawings.
   D. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.6 FABRICATION
   A. Factory fabricate automatic door operators to comply with indicated standards.
   B. Form aluminum shapes before finishing.
   C. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
   D. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

2.7 ACCESSORIES
   A. Signage: As required by cited BHMA standard for type of door and its operation.
      2. Provide sign materials with instructions for field application when operators are installed.

2.8 GENERAL FINISH REQUIREMENTS
   A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.
   B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES
   A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
   B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
   C. Verify that full-height finger guards are installed at each door with pivot hinges where door has a clearance at hinge side greater than 1/4 inch and less than 3/4 inch with door in any position.
   D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. General: Install automatic door operators according to manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
      1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
      2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
   B. Controls: Install activation and safety devices according to manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   C. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 FIELD QUALITY CONTROL
   A. Certified Inspector: Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
   B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
      1. Test and inspect each automatic door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
   C. Automatic door operators will be considered defective if they do not pass tests and inspections.
   D. Prepare test and inspection reports.
3.4 ADJUSTING
   A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
   B. After completing installation of automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
   C. Readjust automatic door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
   D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Doors.
   2. Interior borrowed lites.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

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

1.5 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: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer’s published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.

1.6 ACTION SUBMITTALS
A. Product Data: For each glass product and glazing material indicated.
B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
C. Glazing Accessory Samples: For gaskets, in 12-inch lengths.
D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.7 INFORMATIONAL SUBMITTALS
A. Qualification Data: For installers.
B. Product Certificates: For glass and glazing products, from manufacturer.
C. Preconstruction adhesion and compatibility test report.
D. Warranties: Sample of special warranties.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association’s Certified Glass Installer Program.
B. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
D. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated.
E. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

F. 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.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes. Provide cushions at edges of glass to prevent impact damage during shipment and storage.

1.10 PROJECT 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 below 40 deg F.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   1. Minimum Glass Thickness for Lites: 6.0 mm, unless otherwise indicated.

B. 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.

2.2 GLASS PRODUCTS

A. 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.

2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from the following:
   1. Silicone complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned silicone gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

Glazing
Rev. A, 03/16/15
Issue for Bid
2.4 GLAZING SEALANTS
   A. General:
      1. Compatibility: Provide glazing sealants that are compatible with one another and with other
         materials they will contact, including glass products, seals of insulating-glass units, and
         glazing channel substrates, under conditions of service and application, as demonstrated by
         sealant manufacturer based on testing and field experience.
      2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting
         glazing sealants suitable for applications indicated and for conditions existing at time of
         installation.
      3. Colors of Exposed Glazing Sealants: As selected by Owner’s Representative from
         manufacturer's full range.
   B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S,
      Grade NS, Class 100/50, Use NT.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. Dow Corning Corporation; Dow Corning® 790 Silicone Building Sealant.
         b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2700 SilPruf
            LM.
         c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 290.
         d. Pecora Corporation; 890NST.
         e. Sika Corporation; SikaSil WS-290.
         f. Tremco Incorporated; Spectrum 1.

2.5 GLAZING TAPES
   A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape;
      nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as
      recommended in writing by tape and glass manufacturers for application indicated; and complying
      with ASTM C 1281 and AAMA 800 for products indicated below:
      1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
      2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous
         pressure.
   B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on
      both surfaces; and complying with AA
      MA 800 for the following types:
      1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
      2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a
         full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS
   A. General: Provide products of material, size, and shape complying with referenced glazing standard,
      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.
2.7  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. Grind smooth and polish exposed glass edges and corners.

2.8  MONOLITHIC-GLASS TYPES
   A. Glass Type GL-1: Clear fully tempered float glass.
      1. Thickness: 6.0 mm.
      2. Provide safety glazing labeling.

PART 3 - EXECUTION

3.1  EXAMINATION
   A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the
      following:
      1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at
         corners.
      2. 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.

3.2  PREPARATION
   A. Clean glazing channels and other framing members receiving glass immediately before glazing.
      Remove coatings not firmly bonded to substrates.
   B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that
      exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible
      marks in the completed work.

3.3  GLAZING, GENERAL
   A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other
      glazing materials, unless more stringent requirements are indicated, including those in referenced
      glazing publications.
   B. Adjust glazing channel dimensions as required by Project conditions during installation to provide
      necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with
      reasonable tolerances.
   C. Protect glass edges from damage during handling and installation. Remove damaged glass from
      Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other
      imperfections that, when installed, could weaken glass and impair performance and appearance.
   D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by
      preconstruction testing.
   E. 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.
   F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
G. 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.

H. 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.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. 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.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. 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; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project 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.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Non-load-bearing steel framing systems for interior partitions.
   2. Suspension systems for interior ceilings and soffits.
   3. Grid suspension systems for gypsum board ceilings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Studs and Runners: Provide documentation that framing members’ certification is according to SIFA’s "Code Compliance Certification Program for Cold-Formed Steel Structural and Non-Structural Framing Members."

1.4 INFORMATIONAL SUBMITTALS
A. Evaluation Reports: For firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS
A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

B. Studs and Runners: ASTM C 645.
   1. Steel Studs and Runners:
      a. Minimum Base-Metal Thickness: 0.033 inch (20 gauge), unless noted otherwise on Drawings.
      b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:
   1. Slotted Deflection Track: Steel sheet top runner 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.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) ClarkDietrich Metal Framing; MaxTrak Slotted Deflection Track.
         2) MBA Building Supplies; Slotted Deflecto Track.
         3) Sliptrack Systems; SLP-TRK Slotted Deflection Track.
         4) Steel Network Inc. (The); VertiTrack VTD Series.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.033 inch (20 gauge).

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (16 gauge) minimum base-metal thickness, with minimum 1/2-inch wide flanges.
   1. Depth: 1-1/2 inches unless otherwise indicated on Drawings.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch thick, galvanized steel.

F. Cold-Rolled Furring Channels: 0.053-inch uncoated steel thickness, with minimum 1/2-inch wide flanges.
   1. Depth: 3/4 inch unless otherwise indicated on Drawings.
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

2.2 SUSPENSION SYSTEMS
A. Tie Wire: ASTM A 641/A 641M, 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. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
   2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
   1. Depth: 2 inches unless otherwise indicated on Drawings.

E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Chicago Metallic Corporation; Drywall Grid System.
   c. USG Corporation; Drywall Suspension System.

2.3 **AUXILIARY MATERIALS**

   **A. General:** Provide auxiliary materials that comply with referenced installation standards.

   **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

3.1 **EXAMINATION**

   **A.** Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

   **B.** Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

   **A.** Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 **INSTALLATION, GENERAL**

   **A.** Installation Standard: ASTM C 754.

   1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.

   2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

   **B.** Install framing and accessories plumb, square, and true to line, with connections securely fastened.

   **C.** Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

   **D.** Install bracing at terminations in assemblies.

   **E.** Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 **INSTALLING FRAMED ASSEMBLIES**

   **A.** Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

   1. Single-Layer Application: 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 (runners) 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. 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.

E. Install framing with gypsum board on both sides unless otherwise indicated on the drawings. Where drawings indicate gypsum board at one side only, provide diagonal strapping across unfinished side so that each stud is crossed; or, provide clips to nearest structure at 4 feet on center in each direction.

F. 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.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.

2. Carrying Channels (Main Runners): 48 inches o.c.

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. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. 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.

E. 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
SECTION 092300  GYPSUM PLASTERING

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PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Gypsum plastering on unit masonry.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

1.4 QUALITY ASSURANCE
A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockups for each substrate and finish texture indicated for gypsum plastering, including accessories.
      a. Size: 100 sq. ft. in surface area.
   2. Simulate finished lighting conditions for review of mockups.
   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.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS
A. Comply with ASTM C 842 requirements or gypsum plaster manufacturer's written recommendations, whichever are more stringent.
B. Room Temperatures: Maintain temperatures at not less than 55 deg F or greater than 80 deg F for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
C. Avoid conditions that result in gypsum plaster drying out too quickly.
   1. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
   2. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
   3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 ACCESSORIES
A. General: Comply with ASTM C 841, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Alabama Metal Industries Company; a Gibraltar Industries company.
      b. CEMCO; California Expanded Metal Products Co.
      c. ClarkDietrich Building Systems.
      d. MarinoWARE.
      e. Phillips Manufacturing Co.
   4. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
      a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
      b. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
   5. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
   6. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

2.2 MISCELLANEOUS MATERIALS
A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
2.3 BASE-COAT PLASTER MATERIALS
A. High-Strength Gypsum Neat Plaster: ASTM C 28/C 28M, with a minimum, average, dry compressive strength of 2800 psi according to ASTM C 472 for a mix of 100 lb of plaster and 2 cu. ft. of sand.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. USG Corporation; Imperial Veneer Basecoat.
      b. Approved Equal.

B. Aggregates for Base-Coat Plasters: ASTM C 35, sand to match existing wall texture.

2.4 FINISH-COAT PLASTER MATERIALS
A. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, mill-mixed, gaged, interior finish.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide USG Corporation; Imperial Veneer Finish Plaster or a comparable product by one of the following:
      b. Approved Equal.

B. Aggregates for Float Finishes: ASTM C 35, sand; graded according to ASTM C 842.

2.5 PLASTER MIXES
A. Mixing: Comply with ASTM C 842 and manufacturer's written instructions for applications indicated.

B. Mix Additives: Use accelerators and retarders, if required by Project conditions, according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.3 INSTALLATION, GENERAL
A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.

B. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.
3.4 INSTALLING ACCESSORIES
   A. General: Install according to ASTM C 841.
   B. Cornerbeads: Install at external corners.
   C. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.
   D. Control Joints: Locate as approved by Architect for visual effect, with spacing between joints in either direction not exceeding the following:
      1. Partitions: 30 feet.
      2. Ceilings: 30 feet.

3.5 PLASTER APPLICATION
   A. General: Comply with ASTM C 842.
      1. Do not deviate more than plus or minus 1/8 inch in 10 feet from a true plane in finished plaster surfaces when measured by a 10-foot straightedge placed on surface.
      2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
      3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
   B. Bonding Compound: Apply on unit masonry substrates for direct application of plaster.
   C. Base-Coat Plaster:
      1. Over Unit Masonry: Gypsum neat plaster with job-mixed sand.
   D. Finish Coats:
      1. Textured Finishes: Match existing.
         b. Locations: Provide textured finish where indicated and to match exiting adjacent surfaces.
   E. Concealed Plaster:
      1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
      2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
      3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.6 PLASTER REPAIRS
   A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.7 CLEANING AND PROTECTION
   A. Remove temporary protection and enclosure of other work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

B. Related Requirements:
   1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
   2. Section 092613 "Gypsum Veneer Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.
   3. Section 099123 "Interior Painting" for primers applied to gypsum board surfaces.
   4. Section 099600 "High Performance Coatings" for special coatings applied to gypsum board surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products: Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
1.4 QUALITY ASSURANCE
A. Mockups: Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockups for the following:
      a. Plaster on gypsum board finish indicated for use in exposed locations.
   2. Simulate finished lighting conditions for review of mockups.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 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.

1.6 FIELD CONDITIONS
A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL
A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD
A. Gypsum Board, Type X: ASTM C 1396/C 1396M. (GWB-1)
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. American Gypsum; FireBloc® Type X Gypsum Wallboard.
      b. CertainTeed Corporation; ProRoc Type X.
      c. National Gypsum Company; Gold Bond Brand Fire-Shield Wallboard.
      d. United States Gypsum Company; USG Sheetrock® Brand Firecode® X Gypsum Panels.
      e. Or Approved Equal.
   2. Thickness: 5/8 inch.
B. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces. (GWB-2)
   1. **Products:** Subject to compliance with requirements, provide one of the following:
      a. National Gypsum Company; Gold Bond Brand XP Wallboard.
      b. United States Gypsum Company; USG Sheetrock® Brand Mold Tough® Gypsum Panels.
      c. Or Approved Equal.
   2. Core: 5/8 inch, Type X.
   4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. 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 on Drawings.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fry Reglet Corp.
      b. Gordon, Inc.
      c. Pittcon Industries.
   2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
   3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

C. PVC Trim: Flexible accessories of profiles and dimensions indicated on Drawings.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trim-Tex.
      b. Vinyl Corp.
      c. Approved Equal.
   2. Rigid PVC: Made from rust proof, dent resistant PVC. ASTM D3678-97, D1784-03, C1047-99
      a. Class A Flame rating when tested under ASTM E84-10.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Interior Mold and Moisture Resistant Board: Paper unless otherwise recommended by manufacturer of panel.

C. Joint Compound for Interior Gypsum and Mold and Moisture Resistant 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.

2.6 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Refer to specification Section 079200 “Joint Sealants.”

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL
A. Comply with ASTM C 840.
B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch 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. 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. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: Horizontal and vertical surfaces required for fire-resistance-rated assembly.
   2. Mold-Resistant Type: As indicated on Drawings

B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
   3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Owner’s Representative and Architect for visual effect.

C. 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 where indicated.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 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 3: Where indicated on Drawings.
   3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in other Section 099123 "Interior Painting." Level 4 is suitable for surfaces receiving eg-sheen or less sheen finishes.
   4. Level 5: For surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting. It is considered a high-quality gypsum board finish.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.6 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 095113

ACOUSTICAL PANEL CEILINGS

INDEX

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 ACOUSTICAL PANELS, GENERAL

2.3 ACOUSTICAL PANELS (APC-1)

2.4 METAL SUSPENSION SYSTEMS

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PART 3 - EXECUTION

3.1 EXAMINATION

3.2 PREPARATION

3.3 INSTALLATION

3.4 ERECTION TOLERANCES

3.5 FIELD QUALITY CONTROL

3.6 CLEANING
1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
      1. Acoustical Panel: Set of 6-inch-square Samples of each type, color, pattern, and texture.

1.5 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. Suspended ceiling components.
      2. Structural members to which suspension systems will be attached.
      3. Size and location of initial access modules for acoustical panels.
      4. Items penetrating finished ceiling including the following:
         a. Lighting fixtures.
         b. Air outlets and inlets.
         c. Sprinklers.
         d. Access panels.
         e. Perimeter moldings.
   B. Qualification Data: For testing agency.
   C. Product Test Reports: For each acoustical panel ceiling, for tests performed 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.

1.6 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
      2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages 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.
   C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.
1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Comply with ASTM E 1264 for Class C materials.
   2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:
   1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
   2. Suspension System: Obtain each type from single source from single manufacturer.

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

C. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
   1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.

D. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS (APC-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Cortega #770 by Armstrong World Industries or comparable product by one of the following:
   1. Armstrong World Industries, Inc.
   2. CertainTeed Corp.
   3. Chicago Metallic Corporation.
   4. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
   1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
   2. Pattern: CD (perforated, small holes and fissured).

C. Color: White.
D. LR: Not less than 0.90.
E. NRC: Not less than 0.55.
F. CAC: Not less than 33.
G. Edge/Joint Detail: Square.
H. Thickness: 5/8 inch.
I. Modular Size: 24”x24”.
J. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS

A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
   1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. Prelude XL 15/16” or comparable product by one of the following:
   1. CertainTeed Corp.
   2. Gordon, Inc.
   3. USG Interiors, Inc.; Subsidiary of USG Corporation.

C. Wide-Face, Capped, Double-Web, Hot-Dip Galvanized, G60, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized according to ASTM A 653/A 653M, G60 coating designation; with prefinished, cold-rolled, 15/16-inch-wide aluminum caps on flanges.
   2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
   3. Face Design: Flat, flush.

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
   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 E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      a. Type: Postinstalled expansion anchors.
      b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.
   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 E 1190, conducted by a qualified testing and inspecting agency.
B. Wire Hangers, Braces, and Ties: Provide wires as follows:
   2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch diameter bolts.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. or comparable product by one of the following:
   1. Chicago Metallic Corporation.
   2. Fry Reglet Corporation.
   3. Gordon, Inc.
   4. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer’s standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
   1. Provide manufacturer’s standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
   2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079200" Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Coordinate all work with other trades to be performed in or on ceiling system including light fixtures, HVAC equipment, sprinkler systems and wall partition systems.

C. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION
A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
B. Suspend ceiling hangers from building's structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure 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 and publications.
C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs.
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, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. 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 a neat, precise fit.
   1. Arrange directionally patterned acoustical panels 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. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES
A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
B. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
   1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
      a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
      b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
C. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.6 CLEANING
A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer’s written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION
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### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section Includes:
   1. High-performance resinous flooring systems.

B. Related Sections:
   1. Section 079200 "Joint Sealants" for sealants installed at joints in resinous flooring systems.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Initial Selection: For each type of exposed finish required including color, gloss level, and slip resistance qualities of floors.

C. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

D. Product Schedule: For resinous flooring. Use same designations indicated on Drawings.
1.4 INFORMATIONAL SUBMITTALS
A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
B. Material Certificates: For each resinous flooring component, from manufacturer.
C. Material Test Reports: For each resinous flooring system.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.
   1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Contractor shall have completed at least 10 projects of similar size and complexity.
B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
C. Manufacturer Field Technical Service Representatives: Resinous flooring manufacturer shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.
   1. Field Technical Services Representatives shall be employed by the system manufacturer to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.
D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full-thickness mockups on 48-inch square floor area selected by Architect.
      a. Include 48-inch length of integral cove base.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
E. Preinstallation Conference: Conduct conference at Project site.
   1. General contractor shall arrange a meeting not less than thirty days prior to starting work.
      a. Attendance:
         1) General Contractor
         2) Architect/Owner’s Representative.
         3) Manufacturer/Installer's Representative.

1.7 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 and mixing with other components.
B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.
C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.
1.8 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
   1. Maintain material and substrate temperature between 65 and 85 deg F during resinous flooring application and for not less than 24 hours after application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Stonhard; Stonshield HRI or comparable product, approved by Owner’s Representative.
   1. Sika Corporation US.
   2. Tnemec Company, Inc.

2.2 MATERIALS

A. VOC Content of Liquid-Applied Flooring Components: Not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

2.3 HIGH-PERFORMANCE RESINOUS FLOORING (TE-1)

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.

B. System Characteristics:
   1. Color and Pattern: Match Owner’s standard decorative system.
   2. Wearing Surface: Textured for slip resistance to match existing.
   3. Overall System Thickness: 3/16 inch.

C. Base Coat:
   1. Resin: Epoxy Primer.
      a. Number of Coats: One.

D. Body Coats:
   1. Resin: Epoxy.
   2. Application Method: Three component trowel applied mortar with broadcast aggregates.
      a. Number of Coats: Five total (1 trowel coats, 2 undercoats and 2 broadcast coats, 1 broadcast into each undercoat).
   3. Aggregates: Manufacturer's standard.
E. 1st Topcoat: Sealing coat.
   1. Resin: Epoxy.
   a. Stonkote CE4 Basis of Design
   2. Type: Clear.
   3. Finish: Matte.
   4. Number of Coats: Two.

F. 2nd Topcoat: Finish coat.
   1. Resin: VOC Compliant Waterborne Urethane.
   a. Stoneseal GS7 Basis of Design
   2. Type: Clear.
   3. Finish: Match existing, confirm with Owner’s Representative.
   4. Number of Coats: Two.

G. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   1. Compressive Strength: 10,000 psi after 7 days per ASTM C 579.
   2. Tensile Strength: 2,000 psi per ASTM C 307.
   3. Flexural Modulus of Elasticity: 2.0 x 10^6 per ASTM C 580.
   4. Water Absorption: 0.1% per ASTM C 413.
   5. Coefficient of Thermal Expansion: 1.8 x 10^-5 per ASTM C 531.
   6. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch permanent indentation per MIL-D-3134.
   7. Abrasion Resistance: 0.06 gm maximum weight loss per ASTM D 4060.
   8. Flammability: Self-extinguishing per ASTM D 635.
   10. Bond Strength: >400 psi, 100 percent concrete failure per ACI 503R.

H. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 543, Procedure A, for immersion in the following reagents for no fewer than seven days:
   1. Owner will provide listing of reagents likely to contact resinous flooring during in-service use.

2.4 ACCESSORIES
   A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
   B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for joint fill material.
      1. Basis of Design: Stonflex MP7

PART 3 - EXECUTION

3.1 PREPARATION
   A. General: Prepare and clean substrates according to resinous flooring manufacturer’s written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.
   B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
1. Mechanically prepare substrates as follows:
   a. Mechanically prepare with the use of Diamond grinding equipment to provide surface sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring. Or,
   b. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   c. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
   a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. of slab area in 24 hours.
   b. Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
   c. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
   C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
   D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
   E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
   F. Where flooring transitions to an adjacent flooring material, or terminates at a sealed concrete floor, prepare the edge per the details shown in the drawings prior to installing floor.

3.2 APPLICATION
   A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
      1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
      2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
      3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
         a. Apply joint sealant to comply with manufacturer's written recommendations.
   B. Mix and apply primer over properly prepared substrate with strict adherence to manufacturer's installation procedures and coverage rates.
   C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
      1. Integral Cove Base: Match existing.
D. Apply troweled body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.

E. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.

F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.3 TERMINATIONS

A. Chase edges to “lock” the coating system into the concrete substrate along lines of termination.

B. Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the coating to lock in place at point of termination.

3.4 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.
   1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
   3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.6 PROTECTION

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 18 hours.

B. At the end of each workday, remove rubbish, empty cans, rags, and other discarded materials from the project site.

C. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

D. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.
E. At the completion of construction activities of all trades, touch up and restore damaged or defaced coated surfaces.

F. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes surface preparation and the application of paint systems on the following substrates:
   1. Concrete.
   2. Steel.

B. Investigation: This Specification was prepared using the best information available at the time of preparation. The successful contractor shall obtain list of chemicals and materials that will be present in the facility Scope of Work from the Owner’s Representative. This should include all material that could damage the paint finish and all cleaning solutions. The contractor shall ensure that paints specified will be resistant to the listed chemicals, as well as investigate the existing site conditions and confirm, in writing, that the systems specified herein will perform as intended under the site conditions determined during the investigation.
1.3 DEFINITIONS
    A. DFT: Dry Film Thickness
    B. WFT: Wet Film Thickness
    C. Gloss Levels shall be as defined by ASTM D 523, Levels 1-7.

1.4 SUBMITTALS
    A. Product Data: For each type of product indicated. Include preparation requirements and
       application instructions.
    B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat
       indicated.
        1. Submit Samples on rigid backing, 8 inches square.
        2. Step coats on Samples to show each coat required for system.
        3. Label each coat of each Sample.
        4. Label each Sample for location and application area.
    C. Product List: For each product indicated, include the following:
        1. Cross-reference to paint system and locations of application areas. Use same
           designations indicated on Drawings and in schedules.
        2. VOC content. If VOC content is less than the specified VOC content, provide
           justification for using higher VOC content product.
    D. Product List: Cross-reference to paint system and locations of application areas. Use same
       designations indicated on Drawings and in schedules. Include color designations.

1.5 DELIVERY, STORAGE, AND HANDLING
    A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient
       temperatures continuously maintained at not less than 45 deg F.
        1. Maintain containers in clean condition, free of foreign materials and residue.
        2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS
    A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are
       between 50 and 95 deg F or as required by manufacturer if manufacturer's requirements are more
       stringent.
    B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F
       above the dew point; or to damp or wet surfaces, or per manufacturer's requirements if
       manufacturer's requirements are more stringent.

1.7 EXTRA MATERIALS
    A. Furnish extra materials described below that are from same production run (batch mix) as
       materials applied and that are packaged for storage and identified with labels describing
       contents.
        1. Quantity: Furnish an additional 2 percent, but not less than 1 gal. of each material and
           color applied. Where quantity is more than 5 gallons, provide one 5 gallon container
           only.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. PPG Architectural Finishes, Inc.

2.2 PAINT, GENERAL
A. MPI Standards: Provide products that comply with the intent of the referenced MPI standards indicated in the paint systems in Section 3 below, to be reviewed and accepted by the Owner’s Representative and Architect.
   1. Note: The MPI numbers listed in products below are for reference and quality intent only. The Architect does not guarantee that the products listed in this specification are included on the MPI “Approved products list.” The MPI references included in this Specification will be used for a basis of comparison for products submitted from the Manufacturers listed above.

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.
   1. Non-flat Paints and Coatings: 150 g/L.
   2. Primers, Sealers, and Undercoaters: 200 g/L.
   3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.

D. Colors: As selected by Owner’s Representative from manufacturer’s full range.

2.3 SOURCE QUALITY CONTROL
A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner may 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

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements
   for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter
   as follows:
   1. Concrete: 12 percent.
   2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Verify suitability of substrates, including surface conditions and compatibility with existing
   finishes and primers.

F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces
   are dry.
   1. Beginning coating application constitutes Contractor's acceptance of substrates and
      conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural
   Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, machined surfaces, and similar items already in place that are
   not to be painted. If removal is impractical or impossible because of size or weight of item,
   provide surface-applied protection before surface 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.
   2. Do not paint over labels of independent testing agencies or equipment name,
      identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and
   incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers 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 exceeds 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. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal
   fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that
   promote adhesion of subsequently applied paints.
H. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.
   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. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to Owner's Representative.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. 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.

D. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in equipment rooms:
      a. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
      d. Metal conduit.
      e. Plastic conduit.
      f. Tanks that do not have factory-applied final finishes.
      g. 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. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
      d. Metal conduit.
      e. Plastic conduit.
      f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      g. 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.

3.4 FIELD QUALITY CONTROL

A. Wet Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for wet film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that wet 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 wet film thickness that complies with paint manufacturer's written recommendations.

B. 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.

3.5 CLEANING AND PROTECTION
A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE
A. CMU Substrates:
1. Institutional Low-Odor/VOC Latex System:
   c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
      2) Locations: Walls called out to be latex painted.
2. Institutional Low-Odor/VOC Latex System:
   a. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
      b. Locations: Walls called out to be epoxy.
B. Steel Substrates:
  1. Latex System, Alkyd Primer:
     a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
     c. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
     d. Locations: Non-shop primed steel needing paint system.

C. Steel Substrates:
  1. Institutional Low-Odor/VOC Latex System:
     a. Prime Coat: Shop primer specified in Section where substrate is specified.
     c. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
     d. Locations: Hollow metal doors and frames.

D. Gypsum Board Substrates:
  1. Institutional Low-Odor/VOC Latex System:
        1) Basis-of-Design Product: 295 Kel-Bond Uni-Prime All Purpose Primer by Kelly Moore.
     c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
     d. Location: Walls called out to be semi-gloss.

  2. Latex, Flat System:
        1) Basis-of-Design Product: 295 Kel-Bond Uni-Prime All Purpose Primer by Kelly Moore.
     b. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
     c. Location: Ceilings.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Corner guards.
   2. End-wall guards.
B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for custom stainless steel angle corner guards and bumper guards.
   2. Section 087100 "Door Hardware" for metal protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For each type of wall and door protection showing locations and extent.
   1. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS
   A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   B. Store corner-guard covers in a vertical position.

1.7 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
         b. Deterioration of metals, metal finishes, and other materials beyond normal use.
      2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 CORNER GUARDS
   A. Surface-Mounted, Metal Corner Guards (CG-1): Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
      1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Acrovyn CO-8 series or a comparable product by one of the following:
         a. InPro Corporation (IPC).
         b. JL Industries, Inc.; a division of the Activar Construction Products Group.
         c. Korogard Wall Protection Systems; a division of RJF International Corporation.
         d. Pawling Corporation.
         a. Thickness: Minimum 0.0625 inch.
         b. Finish: Directional satin, No. 4.
      3. Wing Size: Nominal 2 by 2 inches.
2.3 END-WALL GUARDS

A. Surface-Mounted, Metal, End-Wall Guards (CG-2): Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Acrovyn SCO-8 or comparable product by one of the following:
   a. InPro Corporation (IPC).
   b. JL Industries, Inc.; a division of the Activar Construction Products Group.
   c. Korogard Wall Protection Systems; a division of RJF International Corporation.
   d. Pawling Corporation.

   a. Thickness: Minimum 0.0625 inch.
   b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 2 by 2 inches.


2.4 MATERIALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M.

B. Adhesive: As recommended by protection-product manufacturer and with a VOC content of 70 g/L or less.

2.5 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

2.6 FINISHES

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

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.
3.3 INSTALLATION
   A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
   B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.

3.4 CLEANING
   A. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Welded corridor lockers.

1.3 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of metal locker.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.
B. Shop Drawings: For metal lockers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Show locker trim and accessories.
   3. Include locker identification system and numbering sequence.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

D. Product Schedule: For lockers. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS
A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:
      a. Identification plates.
      b. Hooks.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.9 FIELD CONDITIONS
A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.10 COORDINATION
A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.11 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation of latches and other door hardware.
   2. Damage from deliberate destruction and vandalism is excluded.
   3. Warranty Period for Welded Metal Lockers: Ten years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and "Texas Accessibility Standards" of the Architectural Barriers Act Article 9102, Texas Civil Statutes.

2.3 WELDED CORRIDOR LOCKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lyon Workspace Products, LLC; All-Welded or a comparable product by one of the following:
   1. Art Metal Products.
   3. List Industries Inc.
   4. Olympus Lockers & Storage Products, Inc.
   5. Penco Products, Inc.

B. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
   1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
   2. Door Style: Vented panel as follows:
      a. Louvered Vents: No fewer than three louver openings at top and bottom for double-tier three louver openings at bottom, for triple-tier lockers.

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
   1. Tops, Bottoms, and Sides: 0.060-inch nominal thickness.
   2. Backs: 0.048-inch nominal thickness.
   3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
   1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
   1. Continuous Hinges: Manufacturer's standard, steel, full height.

F. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
   1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.
      a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Locks: Combination padlocks.

H. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.

I. Hooks: Manufacturer's standard ball-pointed type hooks, aluminum or steel; zinc plated.

J. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.
   1. Height: 4 inches.

K. Continuous Sloping Tops: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.

L. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

M. Boxed End Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

N. Materials:
   1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

O. Finish: Baked enamel or powder coat.
   1. Color: As selected by Owner's Representative and Architect from manufacturer's full range.

2.4 LOCKS

A. Combination Padlocks: Provided by Owner.

2.5 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
   1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
   2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.

C. Equipment: Provide each locker with an identification plate and the following equipment:
   1. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.

D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.

E. Accessible Lockers: Fabricate as follows:
   1. Locate bottom shelf no lower than 15 inches above the floor.
   2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
2.6 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.
   1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
   1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
   2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
   3. Anchor back-to-back metal lockers to floor.

B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.

C. Equipment:
   1. Attach hooks with at least two fasteners.
   2. Identification Plates: Identify metal lockers with identification indicated on Drawings.
      a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.

D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
   1. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
2. Attach sloping-top units to metal lockers, with closures at exposed ends.
3. Attach boxed end panels using concealed fasteners to conceal exposed ends of non-recessed metal lockers.

3.3 ADJUSTING
A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.4 PROTECTION
A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION
# PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Stainless Steel Laboratory Casework and Tables.
2. Countertops, Tabletops and Sinks
3. Laboratory countertops.
4. Shelves.
5. Laboratory sinks.
6. Laboratory accessories.
   b. Mop Holder.
7. Sealant.
8. Water and, laboratory gas service fittings.
9. Laboratory Equipment Schedule.

B. Related Requirements:
1. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework.

1.3 PRE-INSTALLATION MEETINGS
A. Pre-installation Conference: Conduct conference at Project site.

1.4 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.

1.5 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.
   3. Indicate locations and types of service fittings.
   4. Indicate locations of blocking and reinforcements required for installing laboratory casework.
   5. Include details of utility spaces showing supports for conduits and piping.
   6. Include details of support framing system.
   7. Include details of exposed conduits, if required, for service fittings.
   8. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
   9. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples for Initial Selection: For factory-applied finishes and other materials requiring color selection.
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 sink and accessory item specified.
   7. One of each type of hardware item specified.
1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer.
B. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard.
C. 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.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.9 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
2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bedcolab Ltd.
3. Lab Crafters, Inc.
4. Mott Manufacturing Ltd.
B. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

2.2 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:
5. Shelves: 40 lb/sq. ft.
2.3 CASEWORK, GENERAL
   A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 STAINLESS STEEL CABINET AND TABLE MATERIALS
   A. Stainless sheet steel: Type 304, with exposed surfaces ground and polished to a No. 4 satin finish.
   B. Nominal Metal Thickness: 18 gauge, except as follows:
      1. 20 gauge (1.0mm thick): Solid door interior panels, drawer fronts, scribe strips, filler panels, enclosures, drawer bodies, shelves, security panels, and sloping tops.
      2. 16 gauge (1.6mm thick): Top front rails, top rear gussets, intermediate horizontal rails, table legs and frames, leg rails and stretchers.
      3. 14 gauge (2.0mm thick): Drawer suspensions, door and case hinge reinforcements, and front corner reinforcements.
      4. 12 gauge (2.8mm): Table leg corner brackets and gussets for leveling screws.

2.5 COUNTERTOP TABLETOP SHELF AND SINK MATERIALS
   A. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

2.6 STAINLESS STEEL LABORATORY CASEWORK 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. Integrate 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. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
   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. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental 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 diameter 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.
   H. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.
      1. Provide base cabinets with removable backs for access to utility space.
   I. Utility-Space Framing: Steel framing units consisting of two steel slotted channels complying with MFMA-4, not less than 1-5/8 inches square by 0.105-inch nominal thickness, that are connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.
J. 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 utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
   2. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
   3. Seal all panels to avoid any open gaps or pockets.

2.7 STAINLESS STEEL FABRICATIONS

A. Material: Unless otherwise noted stainless steel for work surfaces, canopy hoods, shelves, sinks and scullery sinks shall be Type 304 and shall be of gauge indicated on Laboratory Furnishing drawings or this specification.

B. Finish: All fabrications shall have exposed surfaces ground and polished to a No. 4 satin finish.

C. All stainless steel nuts, screws, bolts, and rivets, etc., shall be of the same type stainless as in the sheet material and shall have a tumbled finish closely resembling that of a No. 4 finish.

D. All stainless steel welding material shall be of type similar to the sheet material or a richer quality. All welds shall be made without discoloration and shall be ground, polished, and passivated to blend harmoniously with a Number 4 satin finish. All joints in stainless steel tops and work surfaces shall be welded.

E. Work Surfaces:
   1. Thickness: 16 gauge.
   2. Fabrication:
      a. Edges: Flanged down the same dimension as the adjacent non-stainless top, if any, with 1 inch being a minimum and returned over a 16 gauge perimeter metal frame to simplify securing top material to cabinet or structural frame, insure rigidity and prevent buckling, warping, or oil canning.
      b. Reinforcement: Under-surface shall be reinforced with full length 16 gauge structural metal channels at rear and middle top to insure rigidity and prevent buckling, warping, or oil canning. Where bench-mounted fittings are indicated on the drawings, provide top reinforcement to allow for rigid, secure mounting of fittings.
      c. Undercoating: Underside of top shall have a heavy mastic agent coating providing sound deadening.
      d. Stainless steel sides and back-splashes, where indicated, shall be integrally welded to top and finish as indicated above. The back side of exposed backsplashes shall be finished to match front and sides.
      e. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form inside corners to a radius of not less than 1/8 inch (3mm). After sawing, rout and file cutouts to ensure smooth, crack-free edges with no burrs.
      f. Marine edges: Where indicated, shall be 1 inch wide and 1/4 inch high with chamfered or radiused transition to and be an integral part of the work surface. Marine edges shall be seamless die-formed.

3. Tops with Sinks: Tops and sinks shall be integral, fabricated with a marine edge and shall be pitched to sink bowl for proper drainage.

4. Flat Stainless Steel Work Surfaces (without marine edge or sink): Provide an integrally coved back splash and bull-nose at front of work surface.

2.8 HARDWARE

A. General: Provide laboratory casework manufacturer’s standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
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: stainless-steel, 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. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-extension, ball-bearing type.

2.9 COUNTERTOPS, TABLETOPS 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.

C. Stainless-Steel Countertops: Made from stainless-steel sheet, not less than 0.062-inch nominal thickness, with No. 4 satin finish.
1. Extend top down 1 inch at edges with a 1/2-inch return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
2. Form backsplash coved to and integral with top surface.
3. Provide raised (marine) edge around perimeter of countertops containing sinks.
4. Factory punch holes for service fittings.
5. Reinforce underside of countertop with channels, or use thicker metal sheet where necessary to ensure rigidity without deflection.
7. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
8. Where stainless-steel sinks occur in stainless-steel countertops, factory weld into one integral unit.
9. After fabricating and welding, grind surfaces smooth, and polish as needed to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

D. Stainless-Steel Shelves: Made from stainless-steel sheet, not less than 0.050-inch nominal thickness, with No. 4 satin finish. Weld shop-made joints. Fold down front edge 3/4 inch; fold up back edge 3 inches. Provide integral stiffening brackets, formed by folding up ends 3/4 inch and welding to upturned back edge. After fabricating, grind welds smooth, and polish as needed to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

E. Stainless-Steel Sinks: Made from stainless-steel sheet, not less than 0.050-inch nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch radius. Slope sink bottoms to outlet. Provide double-wall construction for sink partitions, with top edge rounded to at least 1/2-inch diameter. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth, and polish as needed to produce uniform finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
1. Factory punch holes for fittings.
2. Provide with stainless-steel strainers and tailpieces.
3. Provide with integral rims except where located in stainless-steel countertops.
4. Apply 1/8-inch-thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.

2.10 LABORATORY ACCESSORIES

A. Cylinder Restraint Assemblies: Provide as indicated on drawings.
   1. Wall mounted 2-cylinder restraint bracket. 11 ga hot-rolled steel with powder coat finish. Color to be selected by the Architect.
   2. Basis of Design: USA Safety Model #GB200FS

B. Mop Holder: Provide as indicated on drawings.
   1. Manufacturers: Products complying with this specification may be provided by the following manufacturers.
      a. Life Science Products, Inc., 115 S. Lynchburg St., Chestertown, MD 21620, Tel: 800 638-9874, website: http://www.lspinc.com
      b. Substitutions are permitted.
   2. Basis of Design: Life Science Products, Inc. Broom Stow or equivalent, as specified herein.
   3. Description: 1/4 inch thick by 4 inch high frame of clear anodized extruded aluminum, alloy 6061-T6, or Type 304 stainless steel with No. 4 finish. Top and bottom shall have 1/8 inch (3mm) radius eased edges. Mop holder frame shall project from wall 1 ¾ inches (44mm) and have radiused bends returning to wall for fastening. Design shall minimize opportunity for the collection of dust, dirt, debris, etc., and facilitate cleaning. Mop holder shall be 24 inches long and hold three cleats for mop handles. Cleat shall be replaceable, black, high-impact plastic with dense foam-covered, gravity/pinch type cleat mounted to frame with stainless steel hardware. Frame shall be mounted to wall with stainless steel mounting hardware appropriate for wall construction.
   4. Mop holder shall be mounted with top edge 72 inches (1829mm) above finished floor.

2.11 SEALANT

A. Refer to Section 079200.

B. Sealant shall be installed by installer of the work in this Section.

2.12 WATER AND LABORATORY GAS SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Broen A/S.
   2. Chicago Faucets; Geberit Company.

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.
   1. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.

C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

D. Finish: Chromium plated or Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes.
   1. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white, or other color as approved by Architect.
E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig.
   1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
   2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
F. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than 5 lbf to operate. Provide units designed for working pressure up to 75 psig, with serrated outlets.
   1. Where ball valves are indicated for fuel-gas use, provide locking safety handles that must be [pushed in] [or] [pulled up] before being turned on [unless otherwise indicated].
G. Ground-Key Cocks: Tapered core and handle of one-piece forged brass, ground and lapped, and held in place under constant spring pressure. Provide units designed for working pressure up to 40 psig, with serrated outlets.
H. Steam Valves: Stainless-steel seat and PTFE seat disc. Provide units designed for steam working pressure up to 20 psig, with serrated outlets.
I. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.
   1. Provide units designed for working pressure up to [60 psig] [100 psig] [125 psig].
J. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."
K. Remote-Control Valves: Provide needle valves, straight-through or angle type as indicated for fume hoods and where indicated.
L. Handles: Provide three- or four-arm, forged-brass handles for valves unless otherwise indicated.
   1. Provide lever-type handles for ground-key cocks. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
   2. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
   3. Provide heat-resistant plastic handles for steam valves.
   4. Provide knurled, molded-plastic handles for needle valves.
M. 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.

2.13 LABORATORY EQUIPMENT SCHEDULE

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A. Isolator System – Quad (E-1):
1. Manufacturer:
   a. Class Biologically Clean
2. Unit Description:
   a. Positive Pressure, Quad Double Tiered Isolators
   b. Provide (4) 30” x 24” x 24” Isolators
   c. 1 ½” Steel Powder Coated single shelf frame
   d. HPDE tabletop with inserts for attaching isolator components
   e. Two-way locking wheels
   f. 20 ml vinyl isolators
   g. 3/8” closed foam pads for under isolators
   h. 3” dia filters
   i. 12” transfer ports
   j. 1” neoprene stoppers
   k. Internal racks to accommodate up to 5 mouse cages each
   l. HEPA filtered blowers
3. Dimensions:
   a. 66”W x 35.75”D x 76”H
4. Responsibility:
   a. OFOI – Coordinate utility requirements with owner for fully functioning unit.

B. Isolator System (E-2):
1. Manufacturer:
   a. Class Biologically Clean
2. Unit Description:
   a. Positive Pressure, Double Tiered Isolators
   b. Provide (2) Isolators
   c. 1 ½” Steel Powder Coated single shelf frame
   d. HPDE tabletop with inserts for attaching isolator components
   e. Two-way locking wheels
   f. 20 ml vinyl isolators
   g. 3/8” closed foam pads for under isolators
   h. 5” dia filters
   i. Transfer ports
   j. 2” neoprene stoppers
   k. Internal racks to accommodate up to 5 mouse cages each
   l. HEPA filtered blowers
3. Dimensions:
   a. 66"W x 35.75"D x 76"H

4. Responsibility:
   a. OFOI – Coordinate utility requirements with owner for fully functioning unit.

C. Type II A2 Biological Safety Cabinet (E-3):
1. Manufacturer:
   a. NUAIRE
2. Unit Description:
   a. Labgard NU-677-400 Class II Type A2.
   b. NSF/ANSI 49 compliant.
   c. All welded stainless steel 16 GA, Type 304 pressure tight design.
   d. 12” access opening.
   e. Prop-up work tray.
   f. 5” Heavy Duty lockable castors
   g. Animal Hair / Dander Pre-Filter
   h. GFI Outlets (2)
   i. 115V / 60 Hz
3. Dimensions:
   a. 53 3/8”W x 32 ¾”D x 79-97”H

4. Responsibility:
   a. OFOI

D. Dual Access BSC (E-4):
1. Manufacturer:
   a. NUAIRE
2. Unit Description:
   a. NU-S610-400
   b. Cabinet shall provide airflows & biological safety performance.
   1) Cabinet shall provide biological containment protection for both operator and product.
   2) Cabinet shall be constructed from a combination of 16GA, Type 304 stainless steel for the side plenums and workzone and 16GA CRS for the top filter and base blower enclosures.
   3) Cabinet shall be easily fumigated employing an established procedure such as that recommended by NIH or NSF.
   4) Supply HEPA filter shall be of full cabinet work zone width and depth; work zone below supply HEPA shall be of fixed cross-sectional area.
   5) Supply HEPA filter shall be protected by a perforated metal diffuser covering the entire top of the work zone.
   6) Air velocity from the supply filter shall average 70 to 80 FPM (.35 to .41 m/s) with no single point outside the 20% of average range measured in a horizontal plane defined by bottom edge of window.
   7) Work access opening shall be 12 inches (305mm) high.
   8) Average inflow velocity using calculated exhaust method shall nominally be 105 LPM (.53 m/s).
   c. The cabinet shall be ergonomically designed for maximum user comfort and adjustability.
   1) Front Access Airfoil (1 inch (25mm) width with 1/2 inch (12mm) recessed front grill) designed for arm rest comfort while maintaining containment performance.
   2) Maximum visibility into cabinet workzone shall be at least 25 inches (635mm) from front access airfoil to supply filter diffuser.
3) Cabinet shall have a centrally located instrument panel within the control center that is easily serviced with quick disconnects.

4) The cabinet shall have a hinged window providing a 12 inch (305mm) access opening.

5) Cabinet shall have a large worktray removable with coved corners for easy cleaning.

d. The cabinet shall have all positive pressure plenums surrounded by a vacuum relative to the room.

e. Electrical power shall be supplied with a 12-foot (2.5m), 3-wire cord with plug.

f. Electrical supply should be 115 VAC, 60 Hz at 30 amps protected with thermal circuit breaker from distribution panel.

g. The cabinet shall use a DC ECM Motor with an optimally determined forward-curved to maximize both energy efficiency and filter loading capacity.

h. The cabinet shall have two internal electrical circuits; one for blower/lights and one for the outlets. Each circuit shall be protected with a circuit breaker located in the Control Center.

i. The cabinet shall be listed to meet the requirements of U.S. and Canada electrical/mechanical integrity.

j. Total cabinet airflow shall be controlled via a solid-state DC Motor Controller that provides automatic compensation (constant volume control) for both filter loading and line voltage variances.

k. Balancing of cabinet workzone downflow (recycling flow) to exhaust flow shall be accomplished with internal exhaust flow dampers, externally adjustable. The damper access plugs shall be under a vacuum relative to the room.

l. The cabinet shall be easily transportable through a 36 inch (914mm) wide, 84 inch (2134mm) high door without disassembly.

m. Fluorescent lighting shall be internal mounted and provide 90 to 120 foot-candles on work surface.

n. The ballast to be electronic containing thermal protection with automatic reset.

o. Cabinet shall have minihelic gauges to display pressure drop over the supply HEPA filters.

p. Cabinet shall come standard with two outlets with drip proof covers on side walls. (3 Amp total load connected)

q. Cabinet heat rejected 2750 BTU’s per hour.

r. A 3/8inch ball valve shall be provided in the drain trough beneath the work tray.

s. Motor/blowers shall be positioned so as to create an even filter loading, thereby prolonging the life of the supply HEPA filter, and shall deliver over 180% the initial HEPA filter static pressure with no more than a 10% decrease of CFM.

t. The following optional equipment shall be available to support installation and user requirements:

1) Ground Fault Interrupter for Electrical System

2) Exhaust Interlocks

3. Dimensions:

   a. 59”W x 32-5/8”D x 83”H

4. Responsibility:

   a. CFCl

E. NexGen Lo-Profile Animal Rack (E-5):

1. Manufacturer:

   a. Allentown

2. Unit Description:

   a. Lo-Profile 80 cage single sided rack with removable rack mounted exhaust blower clipped to top.

   b. 50 ACH

   c. Supply Air at 18 CFM.
d. Exhaust Air at 23 CFM.
e. 5’ Dia. Casters
f. Provide Bumpers.
g. Cages as required by owner.

3. Dimensions:
a. 68”W x 24.5”D x 81”H

4. Responsibility:
a. OFOI

F. Animal Cage Changing Station (E-6):
1. Manufacturer:
a. NUaire

2. Unit Description:
a. NU-620-300/E Small Animal Cage Changing Station.
b. Unit constructed of cold rolled steel and aluminum (excluding stainless steel worksurface area) coated with tough corrosive resistant powder coat enamel finish.
c. Supply module shall be supported by two aluminum uprights located at the midpoint of the 30” side allowing for maximum technician access to the worksurface.
d. The station shall have 6” of knee space providing the station user the ability to sit.
e. Hinged scratch resistant polycarbonate windows, one on each side leaving a large 14” access area, again for maximum technician access to the worksurface.
f. Adjustable hydraulic lift system with standard automatic electric lift.
g. The lift system will provide for a 12” worksurface adjustment range.
h. Stainless steel plate castors with 4” diameter wheels with brakes on all four castors.
i. Worksurface shall be stainless steel, type 304, 16 ga. with easy lift handles and tilt-up holding rods for access to exhaust prefilter and cleaning.
j. Down draft plenum under worksurface shall be stainless steel type 304, 16 ga. with a waste chute.
k. Supply and exhaust HEPA filters are 99.99% efficient at 0.3 microns.
l. Flowgard pressure monitors provided monitors pressure in the supply and exhaust plenums.
m. Supply HEPA filter downflow pattern is uniform and velocity is adjustable between 55-65 feet per minute.
n. Supply HEPA filtered downflow is ISO class 4 at rest measured at 0.5 micron particles per cu.ft./min.
o. The supply and exhaust HEPA filter replacement is accomplished by loosening the filter frame from below the filter, removing the side access plate and pulling the filter out the side of the cabinet.
p. Supply prefilter shall be washable or disposable.
q. Exhaust primary prefilter under the worksurface shall be washable or disposable.
r. A waste chute 1.5” x 4” located on the front right side of the worksurface plenum is provided to sweep large waste particles into trash containers to aid in the cleaning process.
s. Blowers capable of automatically handling a 60% minimum increase in filter loading without a decrease in total air delivery of more than 10%. Provide a voltage compensating motor speed controller that automatically compensates for voltage changes to maintain constant voltage to motor. Speed controller will permit manual adjustment to handle a 150% increase in filter loading and maintain total air delivery at or above 90%.
t. Provide LED lighting.
u. The control panel is a modular panel consisting of the blower, light and outlet switches.
v. Outlet/Ratings:
   1) (1) 115V Duplex outlet inside work area (3 Amps)
w. Unit to carry a three (3) year warranty.
x. Utility Requirements:
   1) Elec. 1/60/115V/20Amps
   2) Power shall be supplied with a 12 ft. power cord (molded 20 Amps conf.).

y. The unit shall be listed by UL.

3. Dimensions:
   a. 42"W x 30"D x 83-98"H

4. Responsibility:
   a. OFOI

G. Sterilizer (E-7):
   1. Manufacturer:
      a. Steris Option: STERIS CENTURY Medium Double Door Steam Sterilizer 26" x 37.5" x 36"D Chamber.
      b. Getinge Option: 700 Series Steam Sterilizer for Life Science Applications Model 733LS 26.5" x 36" x 53"D Chamber.

2. Unit Description:
   a. Pass-Thru Cabinet
   b. Controls both sides
   c. Air Differential Seal
   d. Manually operated hinged doors
   e. Vacuum
   f. Double door, Right-Left Hand with operator panel on both sides
   g. Recessed one wall, sterile side
   h. Standard brass and copper threaded piping
   i. Building Steam
   j. 120 V 1 Ph; 208 V 3 Ph
   k. (2) 36” Loading Car and transfer cart.
   l. (3) Transfer Cart
   m. Utility connections:
      1) House Steam, Cold Water, Air, Drain

3. Responsibility:
   a. OFCI
   b. Owner to purchase equipment and contractor to coordinate all utilities required and provide professional installation of the selected sterilizer which is yet to be determined.

H. Misting Tunnel (E-8):
   1. Manufacturer:
      a. Viratek, Inc.

2. Unit Description:
   a. Model No.: LE2828C-EZ Misting Tunnel
   b. Material: wrapped 316 Stainless Steel
   c. 3-way internal drain valve
   d. Electrical: Requires plug-in type, standard GFI outlet 120V/5 Amps/300 Watts
   e. Retractable 10’ Electric Cord
   f. Interior waterproof LED light
   g. Stainless Steel Conveyor
   h. Drain
   i. Clearance:
      1) Minimum 6” on either side. Keep loading and unloading ends clear.

3. Dimensions:
   a. 38”W x 60”L x 67 1/2”H

4. Responsibility:
   a. OFCI
I. HEPA Filtered Exhaust Blower (E-9):
   1. Manufacturer:
      a. Allentown
   2. Unit Description:
      a. ECOFLO Exhaust Blower
      b. Rack Mounted – Removable
      c. Automatic Filter Load Compensation.
      d. Differential Pressure Readings.
      e. Recyclable Aluminum materials
      f. Uses EC motors
      g. HEPA filtration (99.995%)
      h. 115 Volt, 7-23 Watts, .015A
      i. NEMA 5-15P
      j. Temperature/Humidity Sensor
   3. Dimensions:
      a. 22”W x 14”d x 9.7”H
   4. Responsibility:
      a. OFOI

J. Air Shower (E-10):
   1. Manufacturer:
      a. Terra Universal
   2. Unit Description:
      a. AS477 L/PLC/NF/ST
      b. Low profile design to fit within the 9’-0” ceiling height.
      c. Design as indicated on drawings.
      d. Exterior: 16-GA CR Steel, powder coated white
      e. Nozzles: ABS plastic (40 Ea.)
      f. Doors: Anodized aluminum narrow style frame with static dissipative PVC panel.
      g. Interlocking Doors
      h. System Power: 208VAC, 60Hz, 60 Volt 3-phase with neutral 4-wire
      i. Air Speed: up to 8,000 FPM
      j. HEPA Filters – 99.99% polyurethane mini-pleats with thermal plastic separators and aluminum frame.
      k. LED lighting capable of producing 60 FC at 40” AFF.
      l. Hinged, service access panels to be from gowning room and corridor.
      m. Contractor to provide clear opening path of travel of 54” wide from unloading site to installation location.
      n. Unit to meet ISO Standard 14644-1
      o. No floor
      p. PLC touchscreen panel with emergency stop button and system reset button
      q. Infrared presence sensor
      r. (2) Emergency stop buttons.
      s. Return and supply air ducts.
   3. Dimensions:
      a. 58”W x 84”D x 108”H
   4. Responsibility:
      a. CFCI

K. Stainless Steel Pass-Thru (E-11):
   1. Manufacturer:
      a. Terra Universal
   2. Unit Description:
      a. Biosafe+ EP316SS Wall Mt w/ Isolated Interlock
b. Part no. 2636-89C-2

c. Chamber Dimension of 18” x 18” x 18”

d. Electropolished 316 Stainless Steel.

e. Continuous-seam welds and radiused corners.

f. No-lip chamber.

g. Front edge seals against noncontaminating polyurethane inset in doors.

h. Removable stainless steel doors with tempered glass windows.

i. Durable, no-maintenance mechanical interlock, isolated outside the pass-through chamber to preserve smooth internal surfaces, prevents cross contamination.

j. 316 stainless steel mounting brackets; one flush-mount bracket integrated to the chamber's "clean" side; the other bolted in place on the 'dirty' wall side.

k. Wall cut-out should be 2” wider and 1” higher than chamber.

3. Dimensions:

a. 26.3”W x 22”d x 20”H

4. Responsibility:

a. CFCI

L. NexGen Lo-Profile Animal Rack (E-12):

1. Manufacturer:

   a. Allentown

2. Unit Description:

   a. Lo-Profile 70 cage single sided rack with removable rack mounted exhaust blower clipped to top.

   b. 50 ACH

   c. Supply Air at 16 CFM.

   d. Exhaust Air at 20 CFM.

   e. 5’ Dia. Casters

   f. Provide Bumpers.

   g. Cages as required by owner.

3. Dimensions:

   a. 60”W x 24.5”D x 81”H

4. Responsibility:

   a. OFOI

PART 3 - EXECUTION

3.1 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.

3.2 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.


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.

3.3 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 the 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. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.

F. 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. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

G. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.3.
3.5 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, 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.

3.6 INSTALLATION OF SERVICE FITTINGS
   A. Comply with requirements in other Sections for installing water and laboratory gas service fittings and electrical devices.
   B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 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-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

3.8 SERVICE-FITTING SCHEDULE
   A. Water Service Fitting, Type WF-[#]:
      1. Fitting Type: [Swing-spout mixing faucet] [Rigid, gooseneck mixing faucet] [Rigid, gooseneck, single-service faucet] [Remote-control, rigid, gooseneck, single-service faucet] [Single-service hose bibb].
      2. Outlet: [Aerator] [Vacuum breaker and removable serrated outlet].
      4. Additional Requirements: [Self-closing valves] [For reagent-grade water] <Insert requirement>.
   B. Laboratory Steam Service Fitting, Type SF-[#]:
      1. Fitting Type: [Turret] [Line mounted] [Flange type] [Remote-control turret] [Remote-control flange type].
      2. Outlets: [One] [Two, at 90 degrees] [Two, at 180 degrees] [Three] [Four].
      3. Outlet Type: [Straight] [Angled].
   C. Laboratory Gas Service Fitting, Type GF-[#]:
      1. Service: [Air] [Gas (fuel gas)] [Vacuum] <Insert service>.
      2. Fitting Type: [Turret] [Line mounted] [Flange type] [Remote-control turret] [Remote-control flange type].
      3. Outlets: [One] [Two, at 90 degrees] [Two, at 180 degrees] [Three] [Four].
      4. Outlet Type: [Straight] [Angled].
      5. Valve Type: [Ground-key cock] [Ball valve] [Needle valve].
   D. Electrical Service Fitting, Type EF-[#]:
      1. Fitting Type: [Pedestal, single faced] [Pedestal, double faced] [Recessed] [Line mounted].
      2. Device: [One duplex receptacle] [Two duplex receptacles] [Four duplex receptacles] [One switched receptacle] [One duplex receptacle, switch, and pilot light].

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3. Additional Requirements: [GFCI] [TVSS] receptacles.

E. Communication Service Fitting, Type CF-[#]:
1. Fitting Type: [Pedestal, single faced] [Pedestal, double faced] [Recessed] [Line mounted].
2. Device: [One duplex communication receptacle] [Two duplex receptacles].

F. Electrical and Communication Service Fitting, Type ECF-[#]:
1. Fitting Type: [Pedestal, single faced] [Pedestal, double faced] [Recessed] [Line mounted].
2. Device: [One duplex receptacle and one duplex communication receptacle] [Two duplex receptacles and two duplex communication receptacles] [One switched receptacle and one duplex communication receptacle].
3. Additional Requirements: [GFCI] [TVSS] receptacles.

END OF SECTION
SECTION 220411  WATER DISTRIBUTION SPECIALTIES

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PART 1.- GENERAL

1.1.  RELATED DOCUMENTS

Drawings and the general provisions of the contract, including general and supplementary conditions of Division 01 specification sections, apply to this section.

1.3.  SUBMITTALS

Product data for each item specified herein.

1.4.  QUALITY ASSURANCE

ASME B 31.9 “Building Services Piping” for, materials, products, and installation. Safety valves and pressure valves shall bear the appropriate ASME label.

Cross Connections are Prohibited: Water service systems shall be installed so as to prevent contamination from non-potable liquids, solids or gases.

PART 2.- PRODUCTS

2.1.  ACCEPTABLE MANUFACTURERS

General: Water distribution specialties are specified by manufacturer's numbers as to type and quality required. Specified manufacturer's and approved equivalents are as follows:
2.2. WATER DISTRIBUTION SPECIALTIES

2.2.1. Atmospheric Type Vacuum Breaker

Assembly consisting of brass or bronze body, light weight disc float with silicone disc for seating. Comply with requirements of ASSE Standard 1001, ANSI A112.1.1 and CSA B64.

<table>
<thead>
<tr>
<th>Specified Manufacturer</th>
<th>Approved Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watts LF288A Series</td>
<td>Wilkins, Apollo</td>
</tr>
</tbody>
</table>

2.2.4. Reduced Pressure Backflow Preventer

Reduced pressure principle assembly consisting of shutoff valves on inlet and outlet, and strainer on inlet. Lead Free assemblies shall include test cocks, and pressure-differential relief valve located between two (2) positive check valves with removable seating, air gap, vent elbow, vent relief to drain, and comply with requirements of ASSE Standard 1013, AWWA Standard C511.

<table>
<thead>
<tr>
<th>Specified Manufacturer</th>
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</thead>
<tbody>
<tr>
<td>Watts LF909 or LF009 Series</td>
<td>Wilkins, Apollo</td>
</tr>
</tbody>
</table>

2.2.5. Piston Type Water Hammer Arrester

Lead Free piston type, with type “K” or “L” hard drawn copper barrel, brass piston or all stainless steel. Seal lubricant shall be suitable for use in potable water systems, pressure rated for 35 to 150 psi, and comply with requirements of ASSE Standard 1010 and PDI Standard WH-201.

<table>
<thead>
<tr>
<th>Specified Manufacturer</th>
<th>Approved Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jay R. Smith 5000 series</td>
<td>Sioux Chief, Watts, Wilkins</td>
</tr>
</tbody>
</table>

2.2.6. Balance Valve

Lead Free, Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern, with soldered end connections.

<table>
<thead>
<tr>
<th>Specified Manufacturer</th>
<th>Approved Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell &amp; Gossett – Circuit Setter Plus</td>
<td>Taco, Watts</td>
</tr>
</tbody>
</table>

PART 3 – EXECUTION

3.1 INSTALLATION OF WATER DISTRIBUTION SPECIALTIES

Install water distribution specialties in systems as shown, and in compliance with the manufacturer's recommendations and instructions, plumbing code, and authority having jurisdiction.

3.2 WATER DISTRIBUTION SYSTEM DISINFECTION

Cleaning and Disinfect water distribution piping as follows:

Purge all new water distribution piping systems, prior to use.
Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA D652, or as described below:

Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.

Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for three (3) hours.

Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming from the system.

The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

END OF SECTION
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### PART 1. - GENERAL

#### 1.1. QUALITY ASSURANCE

- **Public Law 90-480**: "Architectural Barriers Act of 1968" Current revision
- Code of Federal Regulations "ADA Standards for Accessible Design"
- Architectural Barriers Texas Accessibility Standards (TAS)
- International Plumbing Code (Current Version)
- ANSI Compliance pertaining to materials, products and installation
- ASTM Standards pertaining to materials
- CISPI Cast Iron Soil Pipe Institute recommendations for cast iron pipe

### PART 2. - PRODUCTS

#### 2.1. ACCEPTABLE MANUFACTURERS

**Acceptable Manufacturers**: Subject to compliance with requirements, provide drainage and vent specialties from one of the following:

- Zurn
- Wade
- Josam
- Jay R. Smith

**General**: All products shall be new and free of cracks or other manufacturing defects.

#### 2.2. PIPING SYSTEM APPLICATION TABLE

Refer to the Piping System Application Table (PSAT) attached to this specification section. The table indicates the piping material datasheet to be used for each system, system service type, design pressure, operating pressure and temperatures, test pressures and cleaning procedures.
Refer to the Piping System Application Table (PSAT) located in specification section 230500. The table indicates the piping material datasheet to be used for each system, system service type, design pressure, operating pressure and temperatures, test pressures and cleaning procedures.

2.3. **PIPING DATASHEETS**

Specifications for these piping materials are attached to specification section 230500 in datasheet format.

**PART 3. - EXECUTION**

3.3. **INSTALLATION**

*General Locations and Arrangements:* Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems.

Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.

Use fittings for all changes in direction and all branch connections.

Make changes in direction for drainage and vent piping using appropriate 45° wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends.

Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two (2) fixtures are installed back to back and have a common drain.

Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90° shall be made.

Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

Install building drain pitched down at minimum slope of 1/4" per foot (2%) for piping 3" and smaller, and 1/8" per foot (1%) for piping 4" and larger, unless otherwise noted.

**Joining**

Refer to individual piping system specification data sheet attached.

3.5. **FIELD QUALITY CONTROL**

*Piping System Test:* Test systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

Test for leaks and defects all piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of systems upon completion of the rough piping installation.

Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

Prepare reports for all tests and required corrective action.

3.6. ADJUSTING AND CLEANING

Clean interior of piping system. Remove dirt and debris as work progresses.

3.7. PROTECTION

Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION
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SECTION 220440

PLUMBING FIXTURES

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PART 1. - GENERAL

1.1. QUALITY ASSURANCE

Code of Federal Regulations “ADA Standards for Accessible Design”
Architectural Barriers Texas Accessibility Standards (TAS)
International Plumbing Code (Current Version)
ANSI Compliance pertaining to materials, products and installation
ASTM Standards pertaining to materials

1.2. EXTRA STOCK

Furnish one (1) each of any special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, and seats in a quantity of one kit for each 40 faucets.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Fixtures, equipment and accessories are specified by manufacturer's numbers as to the type and quality required.
Specified manufacturers and approved equivalent manufacturers are as follows:
### FIXTURE, ITEM OR EQUIPMENT

<table>
<thead>
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<th>SPECIFIED AND APPROVED EQUIVALENT MANUFACTURER</th>
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<td>Supply Fittings &amp; Faucets</td>
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<td>Laboratory Supply Fittings &amp; Faucets</td>
<td>Chicago Faucet, T&amp;S Brass, Water Saver</td>
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</tr>
<tr>
<td>Thermostatic Mixing Valves</td>
<td>Leonard, Powers, Symmons</td>
</tr>
</tbody>
</table>

**Special Note:** The Engineer may reject any fixture, equipment item or accessory which in his opinion is not of the type or quality specified in schedule on drawings.

#### 2.2. MATERIALS

- All stainless steel fixtures shall be 14 gauge, type 304 (18-8) nickel bearing stainless steel, with brushed satin finish and sound deadening undercoat, unless otherwise indicated.
- All precast receptors and basins shall be of standard color and set level in a bed of cement mortar per manufacturer requirements.
- All hygienic fixtures used for drinking purposes shall be lead free.
- Fixtures that are wall hung or abut a wall shall have adjacent edges and surfaces factory ground true and square.

#### 2.3. ACCESSORIES AND TRIM

- All escutcheons shall be chrome plated cast brass with set screw.
- All exposed fixture trim shall be polished chrome plated, unless specified otherwise.
- Plumbing trim utilized shall be provided with renewable seats and replaceable internal working components.
- Unless otherwise specified, each lavatory shall be provided with: McGuire LFBV07 - 1/4 turn ball valve with loose key angle stops and M65 3/8” x 12” flexible risers; McGuire 8902 adjustable, semi cast brass P-trap (1-1/4” inlet, 1-1/2” outlet) with ground swivel joint, cleanout plug, slip inlet and 17 gauge 1-1/2” trap arm.
- Provide Truebro Lav Guard 2 E-Z Series pipe covers for wheelchair lavatories.
Unless otherwise specified, each sink shall be provided with: McGuire LFBV07, 1/4 turn ball valve with loose key angle stops and M66 3/8” x 20” flexible risers; McGuire 151 basket strainer, 1-1/2” x 4”, 17 gauge tailpiece with brass locking and coupling nuts, McGuire 8912 adjustable, semi-cast brass P-trap (1-1/2”) with ground swivel joint, cleanout plug, slip inlet and 17 gauge 1-1/2” trap arm.

Provide additional strainers, tailpieces and continuous waste pieces for multiple compartment sinks as required.

2.4. CARRIERS

All wall hung fixtures shall be supported by means of chair carriers as hereinafter specified. Verify space available for carriers and provide appropriate carrier to fit space.

All wall hung sinks and lavatories shall be supported by means of a chair carrier with stub feet at floor, pipe support, supporting arms with leveling and securing screws. Concealed arms shall be provided.

2.5. FIXTURES

Refer to schedule on drawings for plumbing fixtures to be provided. Provide all applicable accessories for its proper operation. Refer to the architectural drawings and the latest edition “Code of Federal Regulations, ADA Standards for Accessible Design” for mounting height, floor space, and clearance requirements.

PART 3. - EXECUTION

3.1. EXAMINATION

Verify all dimensions by field measurements. Examine rough-in for water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

Do not proceed until unsatisfactory conditions have been corrected.

3.2. INSTALLATION

Install plumbing fixtures level and plumb, in accordance with fixture manufacturer’s written instructions, rough-in drawings, pertinent codes and regulations, the original design, and the referenced standards.

Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

Provide all work and material required to rough-in, connect up and install supply, drain, waste, soil and vent piping as required for proper operation.

Install a stop valve in an accessible location in the water connection to each fixture.

Insulate exposed supplies and drain for wheelchair accessible lavatories and sinks.

Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

Set all countertop fixtures with caulking compound and seal edge of rim with white silicone sealant.
All spaces between fixtures and finished surfaces shall be caulked and pointed square with a FDA approved white silicone sealant resulting in a neat and smooth appearance.

Adequately cover and protect all plumbing fixtures with heavy building paper or other means of protection and maintain such covers and protections as may be necessary until completion of all work.

3.3. INSTALLATION OF FLOOR DRAINS

Install floor drains at low points of surface areas to be drained, as indicated. Set tops of drains flush with finished floor, unless otherwise noted.

Trap all drains connected to the building drains, unless specifically shown otherwise.

Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membrane, where penetrated.

3.4. EXISTING FIXTURES

Where existing fixtures are to be removed and reinstalled, provide all new working components as per new fixture requirements.

3.5. FIELD QUALITY CONTROL

Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

Inspect each installed unit for damage. Replace damaged fixtures.

3.6. ADJUSTING

Adjust water pressure at faucets to provide proper flow and stream.

Replace washers of leaking or dripping faucets and stops.

3.7. CLEANING

Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.8. PROTECTION

Provide protective covering for installed fixtures, water coolers, and trim.

Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

END OF SECTION
SECTION 220481

COMPRESSED AIR EQUIPMENT

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1.1. QUALITY ASSURANCE

1.2. DELIVERY, STORAGE, AND HANDLING

PART 2. - PRODUCTS

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PART 3. - EXECUTION

3.1. GENERAL INSTALLATION OF COMPRESSED AIR EQUIPMENT

3.2. INSTALLATION OF AIR COMPRESSORS

3.3. INSTALLATION OF COMPRESSED AIR RECEIVERS

3.4. INSTALLATION OF COMPRESSED AIR DRYERS

PART 1. - GENERAL

1.1. QUALITY ASSURANCE

ANSI - American National Standard Institute

ASME - American Society of Mechanical Engineers - Install compressed air piping system in accordance with ASME B31.9 “Building Services Piping.”

ASTM - American Society for Testing of Materials

CAGI - Compressed Air and Gas Institute - Provide auxiliary piping equipment in accordance with CAGI Standards.

CGA - Compressed Gas Association

NFPA - National Fire Protection Association

1.2. DELIVERY, STORAGE, AND HANDLING

Clean Compressed Air: Equipment, components, and valves shall be specially prepared in a facility equipped to clean, rinse, and purge the materials in accordance with the provisions of CGA pamphlet G-4.1, Cleaning Equipment for Oxygen Service. Components shall be delivered tagged and packaged in accordance with CGA pamphlet G-4.1.

Maintain end-caps on pipe and components through shipping, storage, and handling to prevent end damage and entrance of dirt, debris, and moisture.

If cleaning becomes necessary, wash component in a hot alkaline cleaner-water solution, such as sodium carbonate or trisodium phosphate. After scrubbing, the materials shall be thoroughly rinsed in clean, hot water.
PART 2. - PRODUCTS

General: Provide components listed below. Where not indicated, provide proper selection to comply with installation requirements.

Clean Compressed Air Systems: All parts for clean compressed air system shall be oil free, sized to a -40 degree dew point with filtration to one micron.

2.1. AIR COMPRESSORS

Acceptable Manufacturers: Subject to compliance with requirements, provide air compressors of one of the following:

Gardner Denver
Powerex
Ingersoll Rand
Atlas Copco

Oil-Free Air Compressors

General Description: Provide air cooled, positive displacement, single -stage, oil-free rotary screw. Compressors shall be capable of continuous operation at rated capacities and pressures. Unit shall be fully packaged, skid mounted including compressor, drive motor and starter, lubrication system, regulation system, control system, and sound insulating enclosure.

The units the only connections required to be the intake, exhaust and power connection at the control panel with all wiring, piping and vibration isolation included in the package. Compressors shall be belt driven with no lubricant used in the compression chamber. Air delivered shall be certified Class 0 contaminants per ISO 8573-1. Unit shall have capacity as indicated below or on the drawings with a maximum capacity of 145 PSIG.

Compressors shall be driven by high-efficiency, open drip-proof motors. Unit to be equipped with combination air inlet filter and silencer. Intake air filter shall remove 99.9% of particles 5 micron or larger. Safety valves (ASME stamped) and check valves shall be included. ASME rated moisture separators shall be provided downstream of the intercooler and aftercooler. Condensate from the separators shall be purged automatically.

Cooling System: The compressor shall be provided with air cooled coolers (oil, intercooler, and aftercooler).

Oil System: Lubrication shall be provided by a positive displacement oil pump driven by the main drive shaft. Lubrication system shall include strainer, filter, relief valves, and air cooled oilcooler.

Enclosure and Frame: The entire unit shall be enclosed in a sound insulating enclosure to meet a 75 dB (A) noise level per ANSI S5.1. Enclosure shall have multiple doors for easy access during compressor maintenance. All components shall be fully mounted on a steel frame. Compressor and motor shall be vibration isolated from the main frame.

Air Compressor Control Panel: A programmable controller shall be utilized for compressor control functions. Control panel package shall be pre-wired ready for single-point, electrical connection. Control panel package shall include all necessary switches and step-down transformers mounted and pre-wired to facilitate air compressor operation. Provide a remote alarm contact for general alarm notification to the building management system (BMS).

Safety Devices: The unit shall shut down and alarm for the following faults; low oil pressure, high first stage outlet air temperature, high second stage outlet air temperature, and motor overload.
Starter: Magnetic, Y-Delta type starter for each compressor motor, with 3-coil overload protection and hand-off-automatic selector switch. Provide disconnecting means and overcurrent protection for each starter.

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<td>SED1007</td>
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<tr>
<td>Type of Air Compressor</td>
<td>Oil Free Air Cooled</td>
</tr>
<tr>
<td>Capacity (SCFM)</td>
<td>30.5</td>
</tr>
<tr>
<td>Discharge Pressure (PSIG)</td>
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</tr>
<tr>
<td>Voltage</td>
<td>480</td>
</tr>
<tr>
<td>Phase</td>
<td>3</td>
</tr>
<tr>
<td>Location</td>
<td>Indoors</td>
</tr>
</tbody>
</table>

2.2. COMPRESSED AIR RECEIVERS

Compressed Air Receiver: Provide ASME coded and stamped, vertically mounted compressed air receiver with safety relief pressure valve, site glass, manual and automatic drain valves and pressure gauge with a dial graduated to 1.2 times the safety relief pressure valve setting. Tank shall have a minimum capacity as listed below or on the drawings.

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<tr>
<td>Minimum Capacity (Gallons)</td>
<td>80</td>
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2.3. COMPRESSED AIR DRYERS

2.3.2. Heatless Desiccant Dryer

Provide heatless compressed air dryer. The air dryer shall be capable of reducing the moisture content of the air using compressed air to regenerate the desiccant, without the use of an external heat source. The dryer shall provide a continuous supply of dry air to the process by automatically cycling between the active and regenerating twin dryer vessels via automatic valves. The replaceable drying media used within the towers shall be activated alumina desiccant which is regenerated by purging a side stream of dry air through the offline vessel to atmosphere. To minimize the wasted energy of purge air, the dryer shall be furnished with an electronic dew point monitoring and control system to control regenerative purge cycles. Unit to be completely assembled, pre-wired, pre-piped, filled with desiccant and tested at the factory prior to shipping. Unit shall have the capacity listed as follows or on the drawings.

Manufacturers: Subject to compliance with requirements, provide refrigerant dryer from the following:

- Ingersoll Rand
- Atlas Copco
- Pioneer
- Zander
- or approved equivalent

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</tr>
</tbody>
</table>
PART 3. - EXECUTION

3.1. GENERAL INSTALLATION OF COMPRESSED AIR EQUIPMENT

Install copper piping from aftercooler, air receiver, and/or separator drain outlet(s) to nearest floor drain or as indicated on drawings.

Locate valves to facilitate full accessibility for maintenance, troubleshooting, and visual confirmation of valve position.

Support piping adjacent to equipment independently so pipe weight is not supported by compressor, or other equipment.

3.2. INSTALLATION OF AIR COMPRESSORS

General: Install air compressors in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored to support base, and maintain manufacturer’s recommended clearances.

Support: Install compressors on a concrete pad, and vibration isolators. Compressors shall be installed to limit vibration to adjacent structure.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

Verify that electrical wiring installation is in accordance with submittal data.

3.3. INSTALLATION OF COMPRESSED AIR RECEIVERS

General: Install compressed air receivers in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored to support base, or concrete pad, and maintain manufacturer’s recommended clearances.

3.4. INSTALLATION OF COMPRESSED AIR DRYERS

General: Install compressed air dryers in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored to support base, or concrete pad, and maintain manufacturer’s recommended clearances.

Install copper piping from dryer drain outlet(s) to nearest floor drain or as indicated on drawings.

END OF SECTION
SECTION 220482

COMPRESSED AIR SYSTEM SPECIALTIES

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3.1 INSTALLATION OF COMPRESSED AIR SPECIALTIES ........ 3

PART 1. - GENERAL

1.1. SUMMARY

This specification indicates the requirements for specialty components to be installed on compressed air systems, which include the following:

“CA” Clean Compressed Air

1.2. RELATED DOCUMENTS

In addition to the drawings and general conditions specifications for the project, applicable sections of the following documents apply to and comprise part of this specification section:

- 230010 - Basic Mechanical Requirements
- 230050 - Basic Mechanical Materials and Methods
- 230250 - Mechanical Insulation
- 230500 - Piping Materials and Methods

1.3. QUALITY ASSURANCE

The manufacture and installation of components shall comply with the applicable requirements of the most recent edition of the following codes and standards:

- ASME B31.9 - Building Services Piping
- ASTM
- ANSI
- CAGI
- CGA

1.4. SUBMITTALS

Provide submittal documents in compliance with requirements indicated in specification section 230010.
PART 2 - PRODUCTS

Provide components as described below. Where not indicated, provide proper selection to comply with installation requirements and project drawings, and submit to Engineer for approval.

2.11. FLEXIBLE CONNECTORS, POINT-OF-USE

Flexible connectors shall be rated for a minimum of 150 psi at 300°F. Stainless steel braided or bellows type connectors shall be provided, with connections suitable for mating to the equipment and piping systems.

2.15. SERVICE OUTLETS

Provide quick-connect/disconnect type gas service outlet valves. Fixture orientation shall be from ceiling mount as per drawings. Construct to permit one-handed connection and removal of equipment with positive locking ring, which retains equipment stem in valve during use, and with secondary lock in outlet that prevents equipment from falling to floor when released. Fixture shall include a forged brass body and handle and replaceable stainless steel seat. If required per drawings, regulator shall also be provided. Regulator shall include a tamper resistant adjustment knob, pressure gauge, and be rated for a maximum inlet pressure of 250 psig, an outlet pressure range of 2-110 psig and a temperature range of 0-125°F.

Subject to compliance with specifications, provide service outlets from the following manufacturer:

- With Regulator: WaterSaver Faucet Co. (Basis of Design: L2873-366)

2.16. QUICK-CONNECT OUTLET CONNECTIONS

Provide compressed air quick-connect outlet connections where indicated on the drawings.

Quick-connect outlet connections shall be of 316 stainless steel construction with Viton-A O-rings and automatic double-end shutoff.

Outlets shall be keyed to provide a mechanical lockout system preventing accidental connection of different lines and color-coded sleeves shall be provided to differentiate from other services. Provide engraved plastic plate identifying service type directly below outlet connection. (See specification 016800 for identification requirements).

Subject to compliance with specifications, provide outlet connections from one (1) of the following manufacturers:

- Hansen (Basis of Design: HK Series for CCA service)
- Swagelok (Basis of Design: QC Series for CCA service)
 PART 3 - EXECUTION

3.1 INSTALLATION OF COMPRESSED AIR SPECIALTIES

Specialty components shall be prepared in a facility equipped to clean, rinse, purge, package, tag and deliver the materials in accordance with the provisions of CGA pamphlet G-4.1.

Maintain end caps on components through shipping, storage, and handling to prevent end damage and entrance of dirt, debris, and moisture.

If cleaning becomes necessary, wash component in a solution of hot water and an alkaline cleaner, such as sodium carbonate or trisodium phosphate. After cleaning, the materials shall be thoroughly rinsed in clean, hot water.

Install compressed air specialty components in accordance with manufacturer's recommendations, standard construction practices, and as shown on the drawings. Locate components to facilitate full accessibility for maintenance, troubleshooting, and visual confirmation of position, condensate accumulation and filter pressure drop.

Piping adjacent to flexible connectors shall be supported such that piping weight and forces are not imposed on the flexible connector.

END OF SECTION
SECTION 230010  BASIC MECHANICAL REQUIREMENTS

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PART 1. - GENERAL

1.1. SUMMARY

This section includes basic mechanical requirements for all mechanical systems, including HVAC, piping, plumbing and fire protection.

1.2. RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Divisions 21, 22 and 23.

The requirements of this section apply to all other Division 21, 22, and 23 Sections.

Drawings and Specification Sections are grouped similar to the Construction Standards Institute's master format and to accommodate common construction industry practice. This grouping does not refer whatsoever as to what type of seller, craft, trade, employee or subcontractor should furnish the work and/or materials. Such grouping is not to be construed as an assignment of labor or material to any particular craft or seller.

Contract Drawings are in part schematic, intended to convey the scope of work and indicate the general layout, design and arrangement. Contract Drawings, paper copy or electronic CAD files, are not to be scaled.

Follow Contract Drawings in laying out the work. Check and be familiar with Shop Drawings and contractor prepared Coordination Drawings affecting spaces in which the work will be installed.

Related Sections: The following sections contain requirements that relate to this section:

- 016800 Tagging and Identification
- 017329 Cutting and Patching
- 017423 Final Cleaning
1.3. **CODES, ORDINANCES, AND REGULATIONS**

Comply with applicable national, state, and local codes, ordinances, and regulations, including but not limited to the following:

- National Standard Plumbing Code
- National Electrical Code
- National Fire Protection Association Standards
- International Building Code
- International Plumbing Code
- International Mechanical Code
- International Energy Conservation Code
- International Fire Code
- Electrical Code
- ASTM Applicable American Society of Testing and Materials Standards
- ANSI Applicable American National Standards Institute Standards
- AWS American Welding Society
- AHRI Air-Conditioning Heating and Refrigeration Institute
- ASME American Society of Mechanical Engineers
- CISPI Cast Iron Soil Pipe Institute
- FM Factory Mutual
- IRI Industrial Risk Insurers
- ISO International Standards Organization
- MSS Manufacturers Standardization Society
- UL Underwriters Laboratory
- ADA American Disabilities Act
- O.S.H.A. Regulations
- U.S. Environmental Protection Agency Regulations

1.4. **WARRANTIES AND GUARANTEES**

In addition to warranties called for in other sections of these specifications, work shall be guaranteed against defect due to faulty installation, manufacture, and component design. Warranties and guarantees shall be for a period of not less than one (1) year, beginning on the later date of final acceptance by Owner, or equipment start-up.

Upon written notice from the Owner or Engineer, promptly remedy, without cost to the Owner, any defects occurring or discovered during the guarantee period.
1.5. **SUBMITTALS**

**General**

Provide submittals of material or equipment in accordance with the Submittal Requirement Schedule at the end of this specification section. Some sections have very specific submittal requirements, not indicated in this section, and therefore are indicated in that specific specification section. A submittal is required if an “X” is indicated for that column and item.

**Acceptable Manufacturers**

Subject to compliance with the requirements of the individual specification sections, provide materials and equipment from the indicated manufacturers only. Submittals of material or equipment manufactured by other than those indicated will be returned. If no manufacturers are indicated, then any product or material that complies with the specification and for the intended application is acceptable.

If manufacturers are listed, the first manufacturer is the "basis of design", and all other listed manufacturers are acceptable alternative manufacturers, as long as they also comply with the specification. It should be noted that there may be differences in dimension or installation requirements between the basis of design and others listed and that additional work that may be required by other trades needs to be coordinated with the other trades and provided at no extra cost to the owner.

**Submittal Procedures**

**Coordination**: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that requires sequential activity.

Coordinate transmittal of different types of submittals for related elements of the work so processing will not be delayed by the need to review submittals concurrently for coordination.

The Owner or Owner's Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

**Processing**: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.

Allow ten (10) working days for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Owner or Owner's Representative will promptly advise the Contractor when a submittal being processed must be delayed for coordination.

If an intermediate submittal is necessary, process the same as the initial submittal.

Allow ten (10) working days for reprocessing each submittal.

No extension of contract time will be authorized because of failure to transmit submittals to the Owner or Owner's Representative sufficiently in advance of the work to permit processing.
Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

Provide a space approximately 4” x 5” on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

Provide a space approximately 4” x 5” on the label or beside the title block on Shop Drawings to record the Owner’s or Owner's Representative review and approval markings and the action taken.

Include the following information on the label or title block for processing and recording action taken.

- Project name
- Date
- Name and address of Owner
- Name and address of Engineer
- Name and address of Contractor
- Name and address of subcontractor
- Name and address of supplier
- Name of manufacturer
- Number and title of appropriate Specification Section
- Drawing number and detail references, as appropriate

Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmittal shall list specification section for each item submitted. Transmit each submittal from Contractor to Owner or Owner's Representative using a transmittal form. Submittals received from sources other than the Contractor will be returned without action.

Electronic submittals from Contractor to Owner or Owner’s Representative are acceptable.

The subject line shall clearly indicate the equipment/system being submitted including specification section number.

The body of the email or fax cover sheet shall clearly list the information indicated in the Submittal Preparation section of this specification.

Email attachments shall be in Microsoft Word, AutoCAD, PDF, TIFF or another approved format.

Submittals: Submit one (1) electronic copy of each required submittal. Each submittal shall be provided complete per each specification section. The Engineer will mark and return with action taken and corrections or modifications required. Retain one (1) copy of each for O&M manuals or Enhanced Turn Over Packages (ETOPs).

On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

Schedules: Project schedules indicating proposed work phases and sequences. Include in schedule as a minimum, approvals, equipment release, delivery, fabrication, equipment setting, startup, punch, and cleanup.
Submittal Schedule

Prepare and submit a complete schedule of submittals within ten working days of award of contract.

Coordinate submittal schedule with the Contractor's construction schedule.

Prepare the schedule in chronological order. Provide the following information:

- Scheduled date for the first submittal
- Related Section number
- Submittal category
- Name of subcontractor
- Description of the part of the work covered
- Scheduled date for resubmittal
- Anticipated date for Engineer's final release or approval

Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule to all parties involved.

1.5.1. Review Action

The Contractor is responsible for all data and information on submittals, including quantities, sizes, dimensions, and compliance with the Drawings and Specifications. Checking by the Owner or Owner's Representative is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown is subject to the requirements of the Drawings and Specifications. Contractor is responsible for dimensions and quantities, which shall be confirmed at the job site, and fabrication process and techniques of construction.

Except for submittals for record, information for similar purposes, where action and return is required or requested, the Owner will check each submittal, mark to indicate action taken, and return promptly.

Compliance with specified characteristics is the Contractor's responsibility.

1.5.2. Shop Drawings

Submit information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings, and directions for installation of anchorages. Include as a minimum the following information on drawings or diagrams:

- Dimensions
- Identification of products and materials included
- Compliance with specified standards
- Notation of coordination requirements
- Notation of dimensions established by field measurement
- Clearances for access and service
Sheet Size: Except for templates, patterns and similar full-size drawings, submit Shop Drawings on sheets at least 8½” x 11”, but no larger than 30” x 42”.

Final Submittal: Submit prints required for maintenance manuals, plus the number of prints needed for general distribution.

One (1) of the prints returned shall be marked-up and maintained as a “Record Document.”

Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.5.3. Coordination Drawings:
Mechanical, Electrical, Plumbing and Fire Protection Contract Drawings are diagrammatic. They are not intended to be precise; they are not intended to specify or to show every offset, fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Information and components shown on diagrams, but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.

The contractor shall prepare coordination drawings in either AutoCAD or MicroStation to a scale of 3/8” equals 1’-0” or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work.

Indicate the proposed locations of equipment, piping, ductwork, and materials. Drawings shall include but shall not be limited to the following:

- Clearances for installing and maintaining installation.
- Clearances for servicing and maintaining equipment, including tube removal, filter removal, valves and space for equipment disassembly required for periodic maintenance.
- Equipment connections and support details.
- Exterior wall and roof penetrations.
- Fire-rated wall and floor penetrations.
- Sizes and locations of required concrete pads and bases.
- Valve stem movement.
- Plumbing systems, piping and equipment.
- HVAC piping, systems and equipment.
- Control systems.
- Electrical distribution, systems and equipment.
- Lighting systems and fixtures.
- Sheet Metal Work, components and accessories, terminal boxes, etc.
- Fire protection and sprinkler systems, piping and heads.
- Structural including supplemental steel for equipment, pipe, duct and conduit supports.
- Electrical Equipment Room layouts.
- Partition/room layout.
- Ceiling tile and grid.
- Access panels.
- Smoke and fire dampers.
- Roof drain piping.
- Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit.
- Above ceiling miscellaneous metal.
- Environmental rooms and associated refrigeration/heating systems.
Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades. The initiation of these drawings shall be by the ductwork contractor.

The ductwork contractor shall prepare a complete set of background drawings, showing structure and other information as needed for coordination. He shall show sheet metal layout thereon.

These will be the basis for Coordination Drawings. Each of the mechanical, electrical and other specialty trades shall add their work to these drawings with appropriate elevations and dimensions.

Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

Each trade shall sign and date each coordination drawing. Where conflicts occur with placement of materials of various trades, the contractor will be responsible to coordinate the available space to accommodate all trades.

Any resulting adjustments shall be initialed and dated by all trades. A copy of the coordination drawing will be continuously updated/redlined in the field office to reflect actual installation conditions. It shall be each trades responsibility to keep their portion of the coordination drawing up to date.

1.5.4. Product Data

Collect Product Data into a single submittal for each element of construction or system.

Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.

Product Data Information: Includes catalog cuts, sketches, or bulletins indicating performance characteristics and certified performance curves with operating point indicated, features of equipment, controls, instrumentation, valving, equipment dimensions, materials of construction, estimated weight of unit (i.e., shipping, installed, and operating), heat rejection load when operating, auxiliaries, specialties, or accessories furnished, roughing-in or anchor diagrams and templates, manufacturer's installation instructions, service clearance requirements, standard color charts, and wiring diagrams.

Drawings: Shall include elevation and plan views, and indicate all connections, attachments, and details to indicate field required general details of assembly (i.e., piping, pneumatics, wiring, etc.).

Wiring Diagrams: Shall detail wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
Mark each copy to show applicable choices and options. Where printed Product Data includes information on
several products, some of which are not required, mark copies to indicate the applicable information. Include
the following information with above product data:

- Manufacturer's printed recommendations
- Compliance with recognized trade association standards
- Compliance with recognized testing agency standards
- Application of testing agency labels and seals
- Notation of dimensions verified by field measurement
- Notation of coordination requirements

Do not submit Product Data until compliance with requirements of the Contract Documents has been
confirmed.

Distribution: Furnish copies of final approval submittal to installers, subcontractors, suppliers, manufacturers,
fabricators, and others required for performance of construction activities. Show distribution on transmittal
forms.

Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's
possession.

Do not permit use of unmarked copies of Product Data in connection with construction.

1.5.5. Record Documents

General: Do not use record documents for construction purposes; protect from deterioration and loss, by
keeping them in a secure location; provide access to record documents for the Owner's reference during normal
working hours.

Record Drawings: Maintain a clean, undamaged set of prints of Contract Drawings and Shop Drawings. Mark
the set to show accurately the actual installation where the installation varies from the work as originally shown.
Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are
used, record a cross-reference at the corresponding location on the Contract Drawings.

Give particular attention to concealed elements that would be difficult to measure and record at a later date. If
“Record Drawings” are not up to date with the construction in the field, payment may be withheld until the
“Record Drawings” are updated.

Mark record sets neatly and accurately with red erasable pencil; use other colors to distinguish between
variations in separate categories of the Work.

Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop
Drawings.

Note related Change Order numbers where applicable.

Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable
titles, dates and other identification on the cover of each set.
Prepare record documents including indication of the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of underground piping.
3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

1.5.6. **Operation and Maintenance Manuals**

**Operation and Maintenance Manuals**: Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2”, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:

- Manufacturer name, Model number, and Serial number
- Shop Drawings and Product Data
- Wiring diagrams
- Copies of warranties
- Inspection procedures
- Emergency instructions
- Parts list
- Recommended spare parts list
- Recommended “turn around” cycles
- Certification numbers, reports, forms, and other information if applicable
- Test protocols, or acceptance criteria if applicable

Prepare maintenance manuals to include the following information for equipment and all auxiliary items:

- Description of function, sequence of control, normal operating characteristics and limitations, performance curves, engineering data and tests, control system documentation, and complete nomenclature and commercial numbers of replacement parts.
- **Instructions for Installation**: Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
- Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions; instrument calibration and test procedures.
- Servicing instructions and lubrication charts and schedules.
- Spare parts list shall be furnished listing all parts for equipment. Indicate part number and generic description of equipment part manufacturer. List(s) shall include parts for all peripheral equipment (i.e. vacuum pumps, microprocessor package, auxiliary equipment, etc.).
Recommended Spare Parts List: Vendor shall furnish an itemized, priced list of all recommended spare parts for quoted equipment. Indicate delivery time required if not a stock item. Indicate part number and generic description of both equipment supplier and original part manufacturer if other than supplier. Spare parts list(s) shall include parts for all peripheral equipment (i.e. vacuum pumps, microprocessor package, auxiliary equipment, etc.).

Before Substantial Completion, submit two (2) draft copies of each manual to the Owner or Owner's Representative for review. Include a complete index or table of contents of each manual.

The Owner will return one (1) copy of the draft with comments within 15 days of receipt.

Submit one (1) copy of data in final form at least 15 days before Contractor's request for final observation. This copy will be returned within 15 days after final observation, with comments.

After final observation, make corrections or modifications to comply with the Owner's comments. Submit eight (8) copies of each approved manual to the Owner within 15 days of receipt of the Owner's comments.

1.6. DELIVERY, STORAGE, AND HANDLING

Deliver products, materials and equipment marked with product names, model numbers, types, grades, and compliance labels, and other information needed for identification. Inspect items for shipping damage and refuse, return, or refurbish items to the satisfaction of the Owner. Maintain delivery records for inventory control and for use in processing payment request vouchers. Crosscheck delivery records with project schedule to eliminate work stoppages due to material shortages.

Store products, materials, and equipment in a manner to prevent damage and degradation. Store items on skids or pallets, elevated above the floor or grade. Store items subject to moisture damage in a dry location. Retain protective shipping covers, crates, and cartons during storage. Protect items from contamination by job site dirt, debris, and other foreign matter. Segregate items into groups of like type for job site storage. Provide a secure, fenced and lighted area for outside job site storage.

Handle products, materials, and equipment in accordance with manufacturer's recommendations and recognized industry standards. Utilize lifting lugs, and designated lift points when hoisting equipment. In all cases, carefully handle, transport, and position items to prevent damage during construction. After placement or installation, cover items with tarps or sheeting where required to protect from damage during construction.

1.7. JOB CONDITIONS

Coordinate routing of piping, ductwork, conduit, etc. (see coordination drawings, this section) to allow installation and service access. Refer conflicts to the Owner’s Representative for final decisions as to right-of-way.

Maintain a superintendent or foreman for each trade at the job site when work is being performed and when required for coordination between trades.

1.8. SEISMIC

The Contractor will be responsible for complying with all applicable seismic codes and regulations, for the design and detailing of all seismic bracing requirements related to all the mechanical systems (including but not limited to process piping, building system piping, ductwork, and equipment). The seismic support design calculations shall be prepared and sealed by a licensed professional engineer, and submitted for approval prior to installing any systems. Seismic design criteria are listed in Section 230241: Vibration and Seismic Control.
1.9. UL LISTING

For all modules and skidded equipment assembled or manufactured off site that includes the installation of wiring and/or electrical components, the complete module or skid shall be provided with an UL label. If the module or skid is not readily available with an UL label, the Contractor or Manufacturer shall employ a third party to inspect the assembly of the module or skid.

The Contractor or Manufacturer shall comply with requirements of the local Authority Having Jurisdiction (AHJ) for third party electrical inspections (some states allow exceptions for process or production equipment). Third party electrical inspectors shall be UL or NRTL trained/certified or as approved by the local AHJ.

Third party inspector shall inspect the work at the Contractor’s or Manufacturer’s site and provide a written report to the local AHJ and the Owner indicating what modifications, if any, were required and that the finished product complies with the appropriate standards.

Contractor or Manufacturer shall supply as a separate line item, the cost of this inspection.

1.10. START-UP, ADJUSTMENT, AND INSTRUCTION

Prior to final acceptance, operate systems and equipment for a minimum of 72 continuous hours and until normal operating conditions are achieved, as approved by the Owner. Clean systems and equipment. Install new filters, screens, etc. prior to final acceptance by the Owner.

Demonstrate to and instruct the Owner in the proper operation of all systems and equipment.

Adjust all systems and equipment to provide operation shown and described on the drawings and specified herein. Properly align and adjust drive components, bearings, etc. for all equipment to eliminate excess noise and vibration as acceptable to the Owner.

Should, in the opinion of the Owner or Engineer, the Contractor be unable or unwilling to properly adjust the work, or instruct the Owner in the proper operation of the equipment and systems, adjustment and instruction will be provided by the Owner at the rate of $125.00 per hour with the cost of these services to be paid by the Contractor.

PART 2. - PRODUCTS – NOT APPLICABLE

PART 3. - EXECUTION

3.1. INSTALLATION

General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment.

Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner.
The mechanical and electrical components, and controls for all equipment are selected and sized, based on the equipment specified. If substitutions and/or equivalent equipment are furnished, it shall be the responsibility of all parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown.

If greater capacity or more materials or labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then it shall be the responsibility of the parties involved in providing the substitute and/or equivalent items of equipment to provide all compensation for additional charges made for the proper rough-in, circuitry and connections for the equipment furnished. No additional charges above the Base Bid shall be allowed for such revisions.

3.2. **CLEAN CONSTRUCTION REQUIREMENTS**

Refer to Specification Section 017433 – Clean Area Protocols for additional requirements and information.

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PART 1. - GENERAL

1.1. SUMMARY

This Section includes Basic Mechanical Materials and Methods common to all Division 21, 22 and 23 sections.

1.2. RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Divisions 21, 22 and 23.

016800 – Tagging and Identification
033000 - Cast-in-place Concrete
055000 - Metal Fabrications
099113 – Exterior Painting
099123 - Interior Painting

The requirements of this section apply to all Division 21, 22 and 23 Sections.

1.3. QUALITY ASSURANCE

Qualify welding processes and welding operators in accordance with AWS D1.1-2010 “Structural Welding Code - Steel.”

Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

Project No. 162848.00
1.4. JOB CONDITIONS

General: The following requirements apply:

Protect work, materials and equipment from damage before, during, and after installation. Cap or plug temporary openings. Protect system piping, ductwork, conduit, etc., from accumulation of unwanted debris. Repair or restore rusted or otherwise damaged materials and equipment to “as new” condition as acceptable to the Owner.

Coordinate routing of piping, ductwork, conduit, etc., to allow installation and service access. Refer conflicts to the Owner or Owner's Representative for final decisions as to right-of-way. Coordinate roof and wall openings, housekeeping pads, supporting devices and set sleeves in poured in place concrete as construction progresses.

Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

Rework or modify work installed out of proper sequence that causes conflict with the installation of other work.

Demolition: The following project conditions apply:

Submit schedules, indicating proposed methods and sequence of operations, for selective demolition prior to commencement of Work. Include coordination for interruption of process, process utility, mechanical, lab utilities, plumbing, electrical, data, telephone and all other existing services. Provide details for dust and noise control. Coordinate sequencing with construction phasing and Owner occupancy.

Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

Locate, identify, and protect all services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

Sequencing and Scheduling

Coordinate the interruption and/or disconnection of all services with the Owner. Coordinate the interruption and/or disconnection of electrical or natural gas services with the Owner and the utility company.

Notify the Owner at least five (5) days prior to commencing demolition operations.

Perform demolition in phases as indicated.

PART 2. - PRODUCTS

2.1. EQUIPMENT MANUFACTURER'S NAMEPLATE DATA

Nameplate: For each piece of power operated mechanical equipment provide a permanent nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels showing compliances with testing, and similar essential data. Locate nameplates in an easily observed accessible location.
2.2. SEALANTS

Elastomeric Sealants

One-part, nonacid-curing, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

Acceptable Manufacturers: Subject to compliance with requirements, provide elastomeric sealants of one of the following:

- “Dow Corning 786,” Dow Corning Corp.
- “863 #345 White,” Pecora Corp.

Acrylic-Emulsion Sealants

One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus five (5) percent.

Fire-Resistant Sealants

Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to the Engineer and authorities having jurisdiction.

Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.

Acceptable Manufacturers: Subject to compliance with requirements, provide two-part fire resistant sealants of one of the following:

- “Firestop 3-6548 Silicone RTV Foam,” Dow Corning Corporation
- “Pensil PEN200 Firestop Foam,” Specified Technologies Inc.

One-part, fire stopping, mildew-resistant, silicone sealant consisting of one part elastomeric sealant formulated for use in a through-penetration fire stop system for sealing openings around cables, conduit, pipes and similar penetrations through walls and floors.

Acceptable Manufacturers: Subject to compliance with requirements, provide one-part fire resistant sealants of one of the following:

- “Pensil PEN300,” Specified Technologies Inc
- “CP 25WB+,” 3M Company
- “Fire Barrier Silicone Sealant 2000+,” 3M Company

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Rev. A, 03/16/17 Issue for Bid
2.3. **GROUT**

**Description**: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. **Characteristics**: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
2. **Design Mix**: 5000-psi, 28-day compressive strength.
3. **Packaging**: Premixed and factory packaged.

**PART 3. - EXECUTION**

3.1. **EXAMINATION**

Examine work area for suitability of conditions prior to installation of work. Coordinate location of work with adjacent work. Field verify location of work including dimensions and required clearances prior to proceeding with installation.

Where unsatisfactory or unsuitable conditions are encountered, do not proceed until the appropriate persons have been notified and the conditions corrected.

3.2. **ROUGH-IN**

Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Refer to approved equipment vendor shop drawings for rough-in requirements.

3.3. **INSTALLATIONS**

**General**: Sequence, coordinate, and integrate the various elements of systems, materials, and equipment. Comply with the following requirements:

Coordinate mechanical systems, equipment, and materials installation with other building components.

Verify all dimensions by field measurements.

Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, except where pitch is required for proper drainage.

Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

Install access panel or doors where serviceable equipment is concealed behind finished surfaces.

Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.4. PAINTING

Painting of HVAC systems, equipment and components is specified in Division 09 Sections “Interior Painting” and “Exterior Painting.”

Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5. CONCRETE BASES

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 four (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.”

3.6. ERECTION OF METAL SUPPORTS AND ANCHORAGES

Refer to Division 05 Section "Metal Fabrications" for structural steel.

Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

Field Welding: Comply with AWS D1.1-2010.

3.7. GROUTING

Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
Clean surfaces that will come into contact with grout.

Provide forms as required for placement of grout.

Avoid air entrapment during placement of grout.

Place grout, completely filling equipment bases.

Place grout on concrete bases and provide smooth bearing surface for equipment.

Place grout around anchors.

Cure placed grout.

3.8. **CUTTING AND PATCHING**

Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

Perform cutting, fitting, and patching of mechanical equipment and materials required to:

- Uncover Work to provide for installation of ill-timed Work.
- Remove and replace defective Work.
- Remove and replace Work not conforming to requirements of the Contract Documents.
- Remove samples of installed Work as specified for testing.
- Upon written instructions from the Owner, uncover and restore Work to provide for Owner or Owner's Representative observation of concealed Work.
- Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical items indicated to be removed and items made obsolete by the new Work.
- Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- All openings in the roof, for mechanical pipes or ducts, shall be made weather and watertight using flashing or curb assemblies.
- Openings in fire rated assemblies, made during new construction or demolition, for piping or ductwork, and for sleeves containing piping or ductwork through rated assemblies shall be filled with fire resistant foam sealant as approved by the authority having jurisdiction.
- Patch existing finished and already finished surfaces and building components using new materials matching existing materials, or original installation, and utilize experienced installers.
3.9. **APPLICATION OF SEALANTS AND FLASHING**

**Surface Cleaning for Sealants:** Clean surfaces of joints immediately before applying sealants to comply with recommendations of sealant manufacturer.

Apply sealant primer to cleaned substrates as recommended by sealant manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing sealant.

**General:** Comply with sealant manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

Comply with recommendations of ASTM C 1193, the standard guide for use of joint sealants.

**Tooling:** Immediately after sealant application and prior to the time curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

**Installation of Fire-Stopping Sealant:** Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

**Installation of Penthouse Floor and Roof Flashing Systems:** Install as detailed on the drawings. Seal to penthouse floor, roof, pipe, and ductwork for an airtight seal. If pipe or ductwork is insulated then insulation shall be continuous through flashing.

END OF SECTION
SECTION 230135  METERS AND GAUGES

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PART 1. - GENERAL

1.1. QUALITY ASSURANCE

ANSI and ISA Compliance: Comply with applicable portions of ANSI and International Society of Automation (ISA) standards pertaining to construction and installation of meters and gauges.

1.2. SUBMITTALS

Provide submittal documents in compliance with requirements indicated in specification section 230010.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products from one of the following:

- Pressure and Temperature Indicators
- Temperature/Pressure Indicator Connector Plugs

See attached data sheets.

Pete's Plugs II

2.2. PRESSURE INDICATORS

General: Provide pressure indicators of materials, capacities, and ranges indicated, designed, and constructed for use in service indicated on attached datasheets.

Pressure Gauge Valves: Provide pressure gauge valves between pressure indicators and connection tees on non-sanitary piping systems. Valves to conform to piping specifications for the service on which they are used.

Steam Piping Systems: Provide a steam syphon or 'pigtail' for gauges in non-sanitary steam piping systems. Provide either a vertical or horizontal syphon based on the orientation of the gauge to be installed. Syphon to be schedule 80 A106B carbon steel or 316 stainless steel with NPT connections.
2.3. **TEMPERATURE INDICATORS**

**General**: Provide temperature indicators of materials, capacities, and ranges indicated, designed, and constructed for use in service indicated on attached datasheets.

**Thermowells**: Provide thermowell installation of temperature indicators in piping systems per the data sheet requirements.

2.4. **TEMPERATURE/PRESSURE INDICATOR CONNECTOR PLUGS**

**General**: Provide temperature and pressure indicator connector plugs where indicated, constructed of solid brass or 316L stainless steel. Plugs shall have two (2) valve cores of either Neoprene or Nordel. Equip plug with gasketed screw cap and chain. For use on insulated piping, provide an extended length plug body. Plugs shall be equipped with a 1/4” NPS fitting, and be suitable for inserting 1/8” OD probe assembly from dial type insertion temperature or pressure indicator.

Valve cores shall be rated as follows:

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<td>Nordel - Temperature Range – Continuous</td>
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<td>45°F to 275°F</td>
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<td>Nordel - Temperature – Maximum Intermittent</td>
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<tr>
<td>Nordel - Pressure</td>
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<td>400 psig</td>
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PART 3.- EXECUTION

3.1. **INSTALLATION OF PRESSURE INDICATORS**

**General**: Install pressure indicators where indicated on drawings, and locate at most readable position.

**Steam Piping Systems**: Install with siphon and ball valve for non-sanitary steam piping systems.

**Hydronic Piping Systems**: Install with ball valve for hydronic piping systems.

3.2. **INSTALLATION OF TEMPERATURE INDICATORS**

**General**: Install temperature indicators where indicated on drawings, in vertical upright position, and tilted for easy reading.

**Piping Systems**: Install temperature indicators inside thermowells for all piping systems indicated to have local temperature indicators.

3.3. **INSTALLATION OF TEMPERATURE/PRESSURE INDICATOR CONNECTOR PLUGS**

**Temperature and Pressure Indicator Connector Plugs**: Install temperature and pressure indicator connector plugs where indicated on drawings. Secure cap.

3.4. **ADJUSTING AND CLEANING**

**Adjusting**: Adjust faces of indicators to proper angle for best visibility.

**Cleaning**: Clean windows of indicators and factory-finished surfaces. Replace cracked or broken windows, and repair any scratched or marred surfaces with manufacturer’s touch-up paint.
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PART 1. - GENERAL

1.1. QUALITY ASSURANCE

Fire Performance Characteristics: Provide composite mechanical insulation (insulation, facings, jacket, coverings, sealers, mastics, cements, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less for ductwork and 450 or less for pipe, when tested according to ASTM E 84 (NFPA 255), UL 723, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

Stainless Steel Systems: Insulation for stainless steel systems and equipment shall meet the requirements of ASTM C795 and C871 for chloride levels.


1.2. RELATED DOCUMENTS

In addition to the drawings and general conditions specifications for the project, applicable sections of the following documents apply to and comprise part of this specification section:

230500 – Piping System Application Table (PSAT)
PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed on the insulation datasheet for the particular system.

2.2. INSULATION MATERIALS

<table>
<thead>
<tr>
<th>Attached Datasheet</th>
<th>Insulation Type</th>
<th>Jacket Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>Rigid Fiberglass Pipe Insulation</td>
<td>PVC</td>
</tr>
<tr>
<td>F4</td>
<td>Rigid Fiberglass Pipe Insulation</td>
<td>ASJ+SSL with PVC Fitting Covers</td>
</tr>
<tr>
<td>F7</td>
<td>Fiberglass Flexible Blanket (Duct Wrap)</td>
<td>FSK, with outdoor weatherproofing jacket if applicable</td>
</tr>
</tbody>
</table>

2.3. INSULATING CEMENTS

Insulating Cements: Mineral Fiber, ASTM C 195, thermal conductivity of 1.0 average maximum at 500°F mean temperature, compressive strength of 10 psi at 5 percent deformation.

2.4. ADHESIVES

All adhesives shall be asbestos free. Manufacturer’s recommendation for adhesives shall be followed. See datasheets for further information related to adhesives.

2.5. INSULATION APPLICATIONS

Refer to datasheets in this Section for materials, forms, jackets, and thicknesses required for each insulated system as follows:

2.5.1. PIPING INSULATION APPLICATIONS

Refer to 230500 Piping Systems Application Table for Piping System Insulation Requirements.

2.5.2. DUCTWORK INSULATION APPLICATIONS

<table>
<thead>
<tr>
<th>System</th>
<th>Attached Datasheet</th>
<th>Thickness Category</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Air Ductwork-Occupied rooms</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Return Air Ductwork-Occupied rooms</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Outside Air Ductwork-Occupied rooms</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Supply Air Ductwork-Unoccupied areas</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Return Air Ductwork-Unoccupied areas</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Outside Air Ductwork- Unoccupied rooms</td>
<td>F7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Return Air Ductwork-Unoccupied areas</td>
<td>F9</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Supply Air Ductwork-Mechanical rooms</td>
<td>F7/F8</td>
<td>A</td>
<td>F7 more than 10 ft above floor, F8 below that</td>
</tr>
<tr>
<td>Outside Air Ductwork-Mechanical rooms</td>
<td>F7/F8</td>
<td>A</td>
<td>F7 more than 10 ft above floor, F8 below that</td>
</tr>
<tr>
<td>Relief / Exhaust Air Ductwork-any location</td>
<td>N/A</td>
<td>N/A</td>
<td>No Insulation</td>
</tr>
</tbody>
</table>
PART 3. - EXECUTION

3.1. PREPARATION

Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt from surface. Clean and dry surface per insulation manufacturer’s recommendation.

Install insulation after testing and acceptance of systems. Keep insulation materials dry during application and finishing.

3.2. INSTALLATION, GENERAL

Apply insulation material, accessories, and finishes according to the manufacturer’s printed instructions, and in accordance with recognized industry practices to ensure that insulation thermal and vapor barrier properties are maintained. Apply adhesives and coatings at the manufacturer’s recommended coverage-per-gallon rate.

Install insulation with smooth, straight, and even surfaces. Insulate with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Apply insulation with a minimum number of joints. Stagger joints on double layers of insulation.

Tightly butt longitudinal seams and end joints. Ensure complete and tight fit over surfaces to be covered. Bond with adhesive.

Seal joints, seams and ends to maintain vapor or waterproof barrier on insulation requiring them. Seal penetrations for hangers, supports, anchors, and other projections in insulation.

3.2.1. GRAY SPACE

Hangers and Supports: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in Division 230140 Section "Hangers and Supports". For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

Walls, Floors, and Partitions Penetrations: Apply insulation continuously through walls and partitions. Seal around penetration with fire-rated or non-fire-rated sealant as applicable. Refer to Section 230050 “Basic Mechanical Materials and Methods.”

3.2.2. CLEAN SPACE / CRITICAL SYSTEMS

Clamps: Unless otherwise indicated apply insulation between pipe clamps. Insulation and jacket to stop at each pipe clamp, end of insulation to be sealed with a pre-molded, precut cap. Cap to be same material and thickness as adjacent pipe jacket. Do not seal insulation jacket to pipe clamp.

Walls, Floors, and Partitions Penetrations: Insulation to stop at escutcheon mounted at the ceiling/wall panel. The insulation jacket to extend to the ceiling/wall panel and sealed with caulk to the panel.

Protection: Provide protection for insulation work during remainder of construction period, to avoid damage and deterioration.
3.3. INSTALLATION JACKETS, GENERAL

Pull jacket tight and smooth.

Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket. Secure with adhesive.

**Longitudinal Seams**: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface where jacket overlaps. Secure with adhesive.

Fill and seal voids, openings, punctures, and breaks at penetrations in jackets with vapor barrier coating.

Cover hanger inserts and shields with jacket material matching adjacent pipe insulation.

3.4. INSTALLATION OF PIPING SYSTEM INSULATION

Apply insulation continuously over system piping, fittings, and components including valves, unions, strainers, devices, and specialties, except as otherwise indicated. Coat pipe insulation ends with vapor barrier coating. Apply pre-molded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Use same material and thickness as adjacent pipe insulation. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.

**Items Not Insulated**: Unless otherwise indicated, do not apply insulation to:

- Flexible connectors
- Vibration control devices
- Chrome-plated pipes and fittings (except for handicapped fixtures)

**Roof Penetrations**: Apply insulation for interior applications to a point even with the top of the roof flashing. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least two (2) inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

3.5. INSTALLATION OF DUCTWORK INSULATION

**Items Not Insulated**: Unless otherwise indicated, do not apply insulation to:

- Factory-insulated flexible ducts
- Flexible connectors
- Vibration control devices
- Access panels and doors in air distribution systems

**Corner Angles**: Install corner angles on external corners of insulation on ductwork in exposed spaces before covering with jacketing.

**Pin Covers**: Install plastic pin covers on exposed stab-on pins to prevent injury to personnel working around ductwork.
3.6. INSTALLATION OF EQUIPMENT INSULATION

Items Not Insulated: Unless otherwise indicated, do not apply insulation to: Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections; Flexible connectors; Vibration control devices; Testing laboratory labels and stamps; nameplates, ASME stamps, information and data plates; manholes, hand holes, and inspection ports.

Do not apply insulation to equipment, breechings, or stacks while hot.

Insulation Thicknesses Greater than Two (2) Inches: Install insulation in multiple layers with staggered joints.

Protect exposed corners with corner angles.

Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.

Unless otherwise indicated apply removable insulation covers to:

Steam and Condensate Valves, Strainers and Check Valves
Steam Pressure Reducing Valves
Steam Traps, Float and Thermostatic and Inverted Bucket

3.7. EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation, where indicated on the plans, or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

Repair damaged insulation jackets, by applying jacket material around damaged jacket. Adhere, and seal. Extend patch at least two (2) inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.

END OF SECTION
Manufacturers:

Johns Manville
Owens-Corning Fiberglass Corporation
Knauf Fiberglass

Temperature Rating: 0°F - 850°F

Material: Inorganic, non-chloride, glass fibers, bonded with a thermosetting resin, ASTM C 547, ASTM C 795, Type 1, rigid pipe insulation, jacketed, non-weatherproofed.

Thermal Conductivity: Maximum of 0.25 Btu-in/hr•ft²•°F average at 100°F mean temperature.

Density: Maximum of 10 lb/ft³ average.

Jacket: ASTM C 921, Type I - full vapor barrier type. PVC jacketing, high-impact, ultraviolet-resistant, 20-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes, fastened as recommended by manufacturer. Jacketing shall be provided as a totally sealed system by using Zeston Perma-Weld solvent welding adhesive or equivalent.

Adhesive: Non-flammable, solvent-based. Service Temperature Range, -20°F to 180°F. Produced under the UL Classification and Follow-up service.

PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.

Fastening and Adhesive: As recommended by insulation manufacturer for full vapor barrier installation.

Vapor Barrier Compound: Water-based, fire-resistive composition. Water Vapor Permeance, 0.08 perm maximum. Temperature Range, -20°F to 180°F.

Seal all joints of PVC jacketing not permanently welded with white silicone caulking.

END OF F3
Manufacturers:

Johns Manville
Owens-Corning Fiberglass Corporation
Knauf Fiberglass

Temperature Rating: 0°F - 850°F

Material: Inorganic, non-chloride, glass fibers, bonded with a thermosetting resin, ASTM C 547, ASTM C 795, Type I, rigid pipe insulation, jacketed, non-weatherproofed.

Thermal Conductivity: Maximum of 0.25 Btu-in/hr•ft²•°F average at 100°F mean temperature.

Density: Maximum of 10 lb/ft³ average.

Jacket: ASJ+SSL: Factory applied All-Service jacket conforming to ASTM 1136, consisting of flame-retardant white kraft paper bonded to aluminum foil, reinforced with laminated glass fiber mat. Jacket shall include self-sealing lap for easy closure.

Adhesive: Non-flammable, solvent-based. Service Temperature Range, -20°F to 180°F. Produced under the UL Classification and Follow-up service.

PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.

Fastening and Adhesive: As recommended by insulation manufacturer for full vapor barrier installation.

Vapor Barrier Compound: Water-based, fire-resistive composition. Water Vapor Permeance, 0.08 perm maximum. Temperature Range, -20°F to 180°F.

END OF F4
Manufacturers:

Johns Manville
Owens-Corning Fiberglass Corporation
Knauf Fiberglass
Certain Teed Corporation

Temperature Rating: 0°F - 450°F

Material: Inorganic glass fibers, bonded with a thermosetting resin, ASTM C 553, Type 2 or 3, flexible blanket insulation, minimum 1.5 lb/ft³ density, jacketed.

Thermal Conductivity: Maximum of 0.31 Btu-in/hr•ft²•°F average at 75°F mean temperature.

Jacket: FSK: Factory-applied FSK jacket conforming to ASTM C1136, consisting of aluminum foil bonded to kraft paper, reinforced with laminated glass-fiber-mat.

Adhesive: Non-flammable, solvent-based. Service Temperature Range, -20°F to 180°F. Produced under the UL Classification and Follow-up service.

Vapor Barrier Compound: Water-based, fire-resistive composition. Water Vapor Permeance, 0.04 perm maximum. Temperature Range, -20°F to 180°F.

Corner Angles: Install corner angle on external corners of insulation on ductwork in exposed spaces.

Secure insulation to ducts with longest side or diameter less than 24” with bonding adhesive applied in 6” wide transverse strips on 12” centers.

Secure insulation to ducts with longest side or diameter 24” and larger with anchor pins spaced 12” apart each way. Apply bonding adhesive to prevent sagging of the insulation.

END OF F7
## Fiberglass Insulation Thickness Chart

**Types F1, F2, F3, F4**

### Piping Insulation Thickness Chart (40°F - 500°F)

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>DO NOT USE</th>
<th>Index Temperature Ranges for Insulation Thickness (°F)</th>
<th>Minimum Insulation Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 40</td>
<td>40 to 60</td>
<td>105 to 140</td>
<td>141 to 200</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>1 1/2</td>
<td>1 1/2</td>
<td>1 1/2</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>1 1/2</td>
<td>1 1/2</td>
<td>1 1/2</td>
</tr>
<tr>
<td>1&quot;</td>
<td>1 1/2</td>
<td>1 1/2</td>
<td>1 1/2</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>1 1/2</td>
<td>1 1/2</td>
<td>1 1/2</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>1 1/2</td>
<td>1 1/2</td>
<td>2</td>
</tr>
<tr>
<td>2&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>1 1/2</td>
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<td>2</td>
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<tr>
<td>3&quot;</td>
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<tr>
<td>4&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>10&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Greater than 10&quot;</td>
<td>1 1/2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### Piping Insulation Notes:

1. These pipe insulation thicknesses meet all the requirements of the 2015, 2012, 2009 and 2006 International Codes, the 2013 and 2010 ASHRAE 90.1 standard, the 2013 California Title 24 codes, condensation control and personnel protection. They are based on the thermal conductivity as listed in specification 230250 datasheets. If the Contractor is proposing materials with higher conductivity, then greater thicknesses may be required and the Contractor shall provide calculations to the Engineer for review and approval.

2. Index temperature ranges for piping are not necessarily the actual fluid temperature, but rather they are the temperature ranges selected by the Engineer upon which to base insulation thickness. Differences between actual fluid temperature and chosen index temperature may account for factors such as transient room temperature and humidity situations. See the Piping Systems Application Table in specification 230500 for required index temperatures for each fluid type.

3. Do not use fiberglass insulation on piping with fluids colder than 40F in any location, or on piping with fluids 60F or below where it is located outdoors in humid climates, unless approved by the Engineer.

4. For thermal conductivities different than the values in specification datasheets, the minimum thickness (T) shall be determined as follows:

   \[ T = r \{ (1 + t/r)K/k - 1 \} \]

   where:
   - \( T \) = minimum insulation thickness (in.),
   - \( r \) = actual outside radius of pipe (in.),
   - \( t \) = insulation thickness listed in this table for applicable index temperature and pipe size,
   - \( K \) = thermal conductivity of proposed insulation material at mean rating temperature between the applicable index temperature and the room temperature, (Btu·in./h·ft·°F);
   - \( k \) = thermal conductivity listed in the applicable insulation datasheet for the same mean temperature between the applicable index temperature and the room temperature, (Btu·in./h·ft·°F)
Ductwork and Equipment Insulation Thickness Chart (40°F - 500°F)
Types F7, F8, F9, F10, F11, F12, F13, F14

<table>
<thead>
<tr>
<th>Duct Location</th>
<th>Insulation Thickness Category</th>
<th>Minimum Installed R-value (Btu.in./[h.ft².°F])</th>
<th>Nominal Uncompressed Insulation Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generally indoors - See specification 230250 for actual locations</td>
<td>A</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

Ductwork and Equipment Insulation Notes:

1. Refer to specification 230250 for the insulation category and location of duct systems and equipment where insulation is required on this project.

2. Insulation thicknesses listed are for information only. The R-value is the actual requirement. Insulation thicknesses listed are nominal and uncompressed. Per codes, actual installed conditions include 25% compression for duct wrap insulation. Compression does not apply to board and liner insulation.
This specification indicates the requirements for the manufacture, installation and testing of piping and associated valves and fittings. Attached to and part of this specification are data sheets for the individual piping materials and components identified by the piping specification number on the drawings.

Specialty components for specific piping services, automated valves, instrumentation, insulation and piping supports are specified in other specifications.

In addition to the drawings and general conditions specifications for the project, applicable sections of the following documents apply to and comprise part of this specification section:

016800 – Tagging and Identification
220420 – Drainage and Vent Systems
1.3. QUALITY ASSURANCE

The manufacture, installation and testing of piping and components shall comply with the applicable requirements of the most recent edition of the following codes and standards:

AGA – American Gas Association
ANSI – American National Standards Institute
ISO – International Organization for Standardization
ASME B31 – Code for Pressure Piping
ASME BPE – Bioprocess Equipment
ASTM – American Society for Testing Materials
AWS – American Welding Society
MSS – Manufacturers Standardization Society
CGA – Compressed Gas Association
CSA International – Canadian Standards Association
NSF 61 – National Sanitation Foundation Drinking Water System Components
UL – Underwriters Laboratories
IMC – International Mechanical Code
IPC – International Plumbing Code

Regulatory Requirements: Comply with the provisions indicated in attached individual piping data sheets, or as required under Part 2 - Products of this section. Submit welders' certificates where applicable for piping material.

Welder's Qualifications: All welders shall be qualified in accordance with applicable code requirements. Qualification shall be made in accordance with each code as identified per the Piping System Application Table and, if applicable, the ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications or AWS B 2.1 Specification for Welding Procedure and Performance Qualification.

Welding procedures and testing shall comply with the associated ASME Standard as identified in the Piping System Application Table and The American Welding Society.


American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME codes as identified for each system per Piping System Application Table.

Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

1.4. SUBMITTALS

Provide submittal documents in compliance with requirements indicated in specification section 230010 for each piping system in the Piping System Application Table.

In addition, provide welders' certifications, and all documentation as required by each associated code sections identified in the Piping System Application Table.
Prior to fabrication of piping systems identified with either ASME BPE, ASME B31.3, or ASME B31.12 in the Piping System Application Table, provide detailed shop drawings of the piping installation, including isometrics of the piping system, which illustrates all fittings, equipment connections, instruments, valves, and welds shall be submitted for approval. Each isometric shall include direction of slope, critical dimensions, and system elevation and location measurements.

All isometrics shall be drawn from the same perspective with relationship to the building, unless a different perspective would provide more detail or better clarification.

Prior to fabrication of piping systems, the Contractor shall note in detailed shop drawings and isometrics where deviations occur between Engineering drawings and Contractor isometrics and/or shop drawings. Changes requiring piping stress analysis rework will be responsibility of the Contractor.

At completion of work, provide record "As-Built" copies of system drawings indicated as ASME BPE, ASME B31.3, or ASME B31.12 for inclusion in Owner's files for validation. Refer to Piping System Application Table to determine systems required to be validated. Include weld numbers in final As-Built drawings where applicable.

PART 2. - PRODUCTS

2.1. PIPE, TUBING, FITTINGS AND MATERIALS

All materials that will be incorporated into permanent piping systems shall be new, unused, and undamaged unless otherwise specifically permitted in the specifications or authorized by the Owner.

Refer to the attached piping material data sheets for specific requirements of each piping material indicated in the table below.

<table>
<thead>
<tr>
<th>DATA SHEET</th>
<th>PIPING MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS03</td>
<td>Carbon Steel Pipe, Sch. 40, Malleable Iron Threaded and welded joints, 150# flanges</td>
</tr>
<tr>
<td>CS05</td>
<td>Carbon Steel Pipe, Sch. 40, Cast Iron Threaded and welded joints, 150# flanges</td>
</tr>
<tr>
<td>CS06</td>
<td>Carbon Steel Pipe, Sch. 80, Cast Iron Threaded and welded joints, 150# flanges</td>
</tr>
<tr>
<td>CU01</td>
<td>Copper Tubing, General Type L, solder joints, 150# flanges</td>
</tr>
<tr>
<td>CI33</td>
<td>Cast Iron, o-Hub, Waste System</td>
</tr>
<tr>
<td>SS03</td>
<td>SST Tubing, 316L, Compression fittings to 1&quot;</td>
</tr>
</tbody>
</table>

The pressure and temperature ratings indicated on the data sheets are nominal for the particular piping, valves and components indicated on the data sheet. The actual allowable pressures vary with temperature and in some cases the valve manufacturers' published limits, but in no case shall exceed the pressure/temperature ratings for the ANSI class indicated, based upon ASME, ASTM and ANSI standards.
2.2. **PIPING SYSTEM APPLICATIONS**

Refer to the attached Piping System Applications Table for the piping material data sheets that apply for each system and the governing ASME Code.

2.3. **JOINING MATERIALS**

**Welding Materials**

Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

**Brazing and Soldering Materials**

Refer to individual piping datasheet specifications for brazing and soldering materials appropriate for each respective system.

**Gaskets for Joints**

Refer to individual piping datasheet specifications for appropriate gasket for each respective system. Materials are specified to suit the chemical and thermal conditions of the fluid of the piping system in which installed, which conform to ASME Standard B16.21, and which are totally non-asbestos.

**Bolting**

Refer to individual piping datasheet specifications for appropriate bolting for each respective system.

Provide anti-seize compound for nuts and bolts.

2.4. **GENERAL PIPING SPECIALTIES**

**Escutcheons for non-clean room spaces**: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

**Dielectric Unions**: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

**Sheet-Metal Sleeves**: 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.

**Steel Sleeves**: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.

**Mechanical Sleeve Seals**: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

**Strainers**: Refer to individual system specialties specifications and drawings for appropriate strainer for each respective system. Provide strainers, with ends matching piping system materials. Arrow indicating direction of flow shall be permanently stamped or cast into body.

Refer to other specification sections for pipe specialty components.
2.5. VALVES

Valve Identification: Provide valves with manufacturer's name and pressure rating clearly marked on valve body.

Model numbers indicated for valves are for guidance only and are subject to change by vendors. Submittals for piping, valves and components shall be based on the verbiage of the specification body and not necessarily the model numbers indicated.

Valves shall be provided as indicated on the drawings, as indicated in the piping material data sheets, and shall otherwise be suitable for the pressure and temperature ratings, and compatible with the conveyed fluid, of the piping systems in which they will be installed. Valves shall be sized to match upstream piping, unless indicated otherwise. Where insulation is indicated or required on piping systems, provide extended valve stems, if available for the type of valve specified, configured to receive insulation.

Valve end connections shall be as indicated in the piping material data sheets, unless indicated otherwise on the drawings.

Valve bypass and drain connections shall comply with MSS SP-45, unless indicated or specified otherwise.

2.5.1. Operators

Provide valve operators as indicated in the piping data sheets, unless indicated otherwise.

Provide chain-wheel actuators for valves 2-1/2” and larger installed 96’ or higher above the finished floor or access platform elevation. Extend chains to an elevation of 5’-0” above finished floor or platform elevation.

Non-rising stem valves may be used where headroom prevents full extension of rising stems.

PART 4. - EXECUTION

4.1. GENERAL

4.1.1. Piping Arrangement

Piping shall be installed per the drawings. Route piping at right angles or parallel to the building structure, free of sags or bends, and grouped together wherever possible. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves. Diagonal runs are not permitted, unless expressly indicated on the drawings.

Arrange piping to allow for ease of access to components that will be serviced regularly as part of the intended operation of the equipment, including the removal of filter housings and valve actuators, and the calibration of instrumentation. Where piping is installed in clean manufacturing areas, sufficient space between piping (or insulation on insulated piping) shall be provided to allow for cleaning, and shall not be less than 1”.

Arrange supports and piping directional changes to allow for thermal expansion in the piping systems due to normal temperature changes. Avoid creating, even temporarily, undue loads, forces, or strains on valves, instrumentation, equipment connections, supports, structural framing, or building components caused by piping connections or supports.

Allow sufficient space above removable ceiling panels to allow for panel removal.
Provide equipment connections with hygienic clamps, compression end, flanged, or threaded connections with unions, based upon the piping material and system, unless otherwise indicated, to allow for complete removal of the equipment without disruption of the connected piping system.

Install drains at low points in piping mains, risers, and branch lines consisting of valve types per section 2.5 of this specification and the system data sheets. Provide caps at ends of valves.

Install air vents at high points of hydronic systems for system air venting, unless otherwise specified.

Install final piping, unions, and flanges at connections to all equipment and fixtures in such a manner that will permit the complete removal of any fixtures or components, such as coils, tube bundles, or filters without cutting pipe lines (e.g., through the uses of swing elbows).

Install instrumentation and other control devices in piping systems where indicated on the drawings.

4.1.2. P&ID Drawings

When Process and Instrumentation Diagrams are provided, they shall be adhered to as much as possible and practical, as they indicate the desired relative locations of piping components, flow paths, and equipment connections to achieve the proper process operations.

Where conflicts arise between the P&IDs and other drawings and specifications, notify the Owner for clarification.

4.1.3. Piping Plan and Elevation Drawings

When piping plan and elevation drawings are provided, they indicate the general location and arrangement of the piping systems and associated valves and components. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, thermal expansion, pump sizing, and other design considerations. To the extent possible and practical, install piping as indicated.

4.1.4. Pipe Penetrations

All pipe penetrations through clean room walls and ceilings, including all clean manufacturing spaces, shall be sealed using clean room wall/ceiling pipe penetration boots.

Boots shall be installed on the pipe on the clean room side of the penetration, prior to the addition of valves and fittings that would prevent the installation of the boot and final positioning against the penetration.

Where pipes penetrate a wall between 2 clean rooms, a boot shall be installed on both side of the wall, and piping insulation installed between the boots to completely insulate the pipe.

All pipe penetrations through non-clean room walls and ceilings shall be provided with an escutcheon on each side of the wall.

The penetration shall be sealed with insulation and sealant. Install sealants by proven techniques that result in sealants directly contacting joints edges, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

The smallest size boot that can adequately seal the pipe to the wall/ceiling surface shall be used. Pipes shall be spaced to prevent interference between the boot ceiling rings of adjacent pipes.

No sealant shall be used between the boot and the wall/ceiling surface.
Where fire stop sealants are required to meet applicable codes for pipe penetrations through fire rated walls and ceilings, the sealants shall be applied to the penetration prior to the attachment of the boot or escutcheon to the wall/ceiling surface.

Route insulation tight to the penetration boots on both sides of the ceiling/wall penetration. Extend the insulation sheathing on the clean room side tight to the ceiling, and cut it back on the dirty side to allow the insulation to be extended tight to the inside of the boot.

If pipe is insulated the insulation shall be continuous through the escutcheon in non-clean room areas.

4.1.5. Preparation

Prepare piping, joints and fittings in accordance with AWS procedures.

Keep all openings in piping, components and equipment closed during construction, except when actual work is being performed on that item or system.

4.1.6. Fittings

Make reductions in pipe sizes using reducer fittings. Eccentric reducers shall be used for all steam, condensate, and critical liquid systems, installed with the straight side down unless indicated otherwise. Vertical lines shall use concentric reducer fittings.

Use fittings for all changes in direction and all branch connections except where bending is specifically allowed by the piping material data sheet. Use long radius elbows unless indicated otherwise, or unless required due to space constraints.

4.1.7. Branch Connections

Branch connection types shall comply with branch connection tables in the piping material data sheets. Orientations of branches shall comply with the following requirements:

Liquids: Take-off from top, bottom, or side of mains or headers at either 45° or 90° from horizontal plane.

Gases: Take-off from top of mains or headers at either 45° or 90° from horizontal plane.

Steam: Take-off from top of mains at either 45° or 90° from horizontal plane, or as indicated on the drawings. Take off at 45° from horizontal plane is preferred.

4.1.8. Connections and Joints

All piping connections and joints shall be made in accordance with appropriate ASME B31 Piping Code sections. The types of joints and connections in a piping system shall be as indicated on the drawings and elsewhere in the project specifications. Welded joints are preferred and shall be used wherever possible and practical, complying with AWS procedures and standards.

Joints indicated as being soldered on copper systems may be brazed on larger sizes if the contractor believes a better joint will be the result. Brazed joints shall be in accordance with AWS standards C3.3, C3.4, C5.10, and D10.13.

Filler material shall be AWS A5.8 BCuP-5 silver copper-phosphorus (15% Ag, 80% Cu, 5% P, nominal composition), and shall otherwise meet the material requirements indicated for that system on the piping data sheet (e.g., lead free for potable water systems).

This approach shall be submitted for approval per system prior to use.
At the final connection to each piece of equipment, adjacent to each control valve or where indicated on drawings, install flanges in piping 2½” and larger and unions in piping 2” and smaller.

Assemble flange joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Tighten bolts gradually to uniformly compress the gaskets and minimize flange stress. Use a calibrated torque wrench to tighten flange and flange bolts to torque specified by manufacturer.

4.1.9. Valves

Locate valves for easy access and provide separate support where necessary. Install valves in horizontal piping with stem at or above the center of the pipe, when possible.

In all cases install valves to allow for easy access for operation. Install valves in a position to allow full stem movement. Protect valves that will be welded, soldered or brazed into piping systems from heat damage.

Valves that have automated actuators or that can be disassembled for maintenance without removal from the connected piping system shall be installed in such a manner that will allow removal of the actuator or serviceable components without disturbing surrounding systems.

Install valves and unions for each fixture and equipment item arranged to allow equipment removal without system shut down. A union connection shall be installed as close as possible to each screwed or soldered end valve.

Install check valves as indicated on the drawings, and for proper direction of flow, oriented to ensure that the valve will close freely and positively under normal operating conditions.

Allow a minimum of five pipe diameters upstream of check valves to minimize chatter and to extend valve life, unless indicated otherwise. Wafer and duo check valves shall be installed between flanges with a horizontal or vertical orientation. Lift check valves shall be installed the stem upright and plumb.

Ball valves with vented balls shall be installed so that when the valve is closed, the interior of the valve is vented to the upstream, pressurized side of the valve, unless indicated otherwise in the specifications or drawings.

4.1.10. Dielectric Unions

Provide dielectric unions with appropriate end connections for the pipe systems in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Dielectric unions are not required for joining stainless steel to carbon steel.

3.1.11. Steam and Condensate Piping Installation

Install steam supply piping at a uniform grade of 1/4” in ten feet downward in the direction of flow, unless otherwise indicated. Install condensate return piping at a uniform grade of 1/2” in ten feet downward in the direction of flow, unless indicated otherwise. Steam branch lines that extend less than 10 feet from the main header can be pitched back towards the header if required to simplify installation.

Install drip legs where indicated on the drawings, as well as at low points and natural drainage points in the system such as at the bottoms of risers, ends of mains, and ahead of pressure regulators, control valves, isolation valves, thermal expansion loops, and expansion joints.

On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet where pipe is pitched down in the direction of the steam flow and a maximum of 150 feet where the pipe is pitched up so that condensate flow is opposite of steam flow.
Size drip legs at vertical risers full size and extend below the drip trap piping to form a dirt leg. Size drip legs at other locations with the same diameter as the main up to 6”.

In steam mains 6” and larger, provide drip legs sized 1/2 the size of the main, but not less than 6”. Drip leg length shall be 1.5 times the pipe size, but not less than 18”, and the dirt leg shall extend at least 6” below the steam trap piping.

Strainers shall be installed upstream of all control valves and steam traps. Strainers shall be oriented with both flow and blow down branches horizontal and level.

3.1.12. **Flushing and Cleaning**

**General**

Clean and flush piping systems after all construction and pressure testing activities are completed. Remove, clean, and replace strainer screens prior to balancing or commissioning.

Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

**Preparation**

Refer to the Piping System Applications Table for type of fluid to be used see below for definition of these media:

“Water” is defined as potable water which is of a quality satisfying the most current EPA Drinking Water Standards and quality attributes at a minimum.

“DI Water” is defined as non-compendial water where potable water is passed through a series of deionization bottles of either anion/cation or mixed bed composition.

“Air” is defined as compressed air where the quality shall be ISO 8573.1 Class 1,2,1 (particles, humidity, and oil, respectively), at a minimum.

“Nitrogen” is defined as compressed nitrogen gas that conforms to the most current USP/NF monograph for nitrogen gas purity.

**Detergent Cleaning of Liquid Pipe Systems**

The cleaning step shall be done with approved BPE detergent blends and DI Water. The detergent solution shall be circulated through the piping systems for a period of time that will provide for complete removal of all contaminants, oils, debris, scale, and residual solutions from the system. A rinse step shall follow the cleaning step, and shall completely remove all of the detergent solution from the system. Removal of the solution shall be coordinated with the Owner. Cleaning shall be considered complete when a sample of the discharge indicates no residual detergent solution and a pH of 6.5 to 7.5.

4.2. **QUALITY CONTROL**

4.2.1. **Pressure Testing**

**General**

After the completion of all welding, fabrication and polishing operations, but prior to insulating, all piping systems shall be pressure tested using the test procedure as indicated within the Piping System Application Table (PSAT) and as specified herein.
No testing shall be performed without being witnessed by the Owner or the Owner’s representative, who shall be notified 48 hours in advance of the test.

All testing procedures shall be approved by the Owner prior to the start of testing. All testing procedures and acceptance criteria must satisfy the corresponding code indicated in the PSAT per system.

Equipment, instruments and components that are not rated for the test pressure shall be isolated from the piping system during pressure tests. If a valve is used to isolate components, its closure shall be capable of sealing against the test pressure without damage to the isolated component.

Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

Joints at which blinds are inserted to isolate equipment need not be tested.

In each system to be tested, install relief valves set at a pressure of no more than 1/3 higher than the test pressure to protect against damage by expansion of liquid or other source of overpressure during the test.

Refer to the Piping System Applications Table (PSAT) for the type of fluid to be used as the pressure testing medium. Compressed air and/or nitrogen for all pneumatic pressure tests shall be of the quality as described in Section 3.1.12 under Preparation.

The pressure testing apparatus shall be constructed of materials that are compatible with the piping system and components being tested. Test apparatus for ASME BPE system piping shall be constructed of stainless steel or polymeric, and shall leave no mineral deposits or other trace residue in the piping system.

Soap solutions utilized for visual examination of pneumatically pressure tested piping systems shall be a commercial preparation made specifically for leak detection. Soap solutions used on ASME BPE piping systems constructed of stainless steel shall be low chloride type.

Provide a temporary test pump, storage tank and other accessories as required to achieve the test pressures specified where not available on site.

**Test Pressures**

Refer to the attached Piping System Applications Table for the piping system test pressure to be used.

**Test Acceptance**

A test will be considered acceptable when all of the conditions of this specification have been met and the test pressure does not change more than 2.0% during the stated test duration. It is required that an Owner designated representative be present to witness and sign for test acceptance.

Provide pressure test documentation including:

- Date of test
- Identification of piping system tested
- Test fluid
- Test pressure
- Test results
- Identities of Test Witnesses
Hydrostatic Testing Procedure

1. With written approval by Owner, prior to hydrostatic pressure testing, the Contractor has the option to perform a low pressure pneumatic pressure test. If the Contractor wishes to perform this preliminary test, Steps 1 through 4 shall be followed from the “Pneumatic Testing Procedure” outlined below. Upon completion of a successful leak check at the pressure in Step 4, the system shall be released of pressure and the remaining steps for Hydrostatic Testing Procedure shall be performed. For this preliminary test, Contractor shall utilize particulate, moisture and oil free air or nitrogen gas of qualities as described in Section 3.1.1 under Preparation.

2. Fill the piping system with appropriate water from a storage tank or other approved source. Owner or Owner’s representative shall approve water quality and source for use with hydrostatic pressure tests.

3. Bleed the system of entrained gases.

4. Circulate the water through the system using a circulating pump for a period of not less than one hour.

5. Inspect all piping for leaks during circulation of water.

6. Slowly close a temporary valve on the discharge side of the piping system.

7. When the test pressure is obtained at the discharge of the pump, the pump shall be shut down and the discharge valve closed. If the circulation pump is not capable of producing the test pressure required for the piping system, provisions shall be made for pressurizing the water filled system with particulate, moisture and oil free air or nitrogen gas of a quality as defined in Section 3.1.1 under Preparation, or a hand pump.

8. Leaks shall be marked and repaired according to the joining methods specified for the piping system being tested.

9. After leaks are repaired, the entire system shall be tested again as specified above.

10. Repeat test procedure until the system is proven tight at test pressure to the satisfaction of the Owner or Owner’s Representative.

11. Hydrostatic test pressure shall be maintained for a sufficient length of time to visually determine whether there are any leaks, but not less than 1 hour. The Contractor shall not be required to maintain test pressure in excess of 2 hours after notification of the Owner’s authorized inspector.

12. If start up is not scheduled to occur within 12 hours after hydrostatic testing, the system shall be completely drained and purged with clean, filtered oil-free, dry air.

Pneumatic Testing Procedure

1. Clear the test area of non-essential personnel before bringing the line pressure up to test pressure. The contractor shall take whatever precautions deemed necessary to protect workers and personnel during pneumatic testing as this testing procedure is inherently dangerous.

2. A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 50 psig or 10% of the test pressure.

3. A double block and bleed valve arrangement shall be included in the pressurizing line to the system being tested. A test gauge shall be located downstream of the double block valve assembly.
4. When pneumatic testing over 25 psig, a preliminary check at 10 psig shall be made to locate major leaks. Examination of the system may be visual or audible. Visual examinations shall utilize a soap solution in order to detect the leakage.

5. After the preliminary check, the test pressure shall be increased in stages of not more than 25% up to full pneumatic test pressure, allowing time for equalization of strains and detection of leaks at each stage. If after a minimum 10-minute period the pressure is held, proceed to the next pressure.

6. If the pressure is not held, examine the entire system for leakage. Examination of the system shall be visual utilizing a soap solution to detect the leakage. All leaks found shall be marked and repaired after first depressurizing the line. After leaks have been repaired, the pressure test shall be repeated. All leaks which have been repaired shall be visually reexamined, with soap, to assure proper repair.

7. After the system has been successfully brought up to the test pressure, the pressure shall then be held for a 10-minute period. After this period, the pressure shall be reduced to the design pressure and held for a duration of 24 hours.

8. Bolting shall not be tightened while systems are being tested above 30 psig.

4.2.2. Weld/Brazing Inspections

General

Welds and brazed connections shall be inspected per the applicable ASME code identified in the PSAT per system. Inspections shall be performed and documented by a qualified 3rd party, separate from the installation contractor. Welds and brazed connections that do not pass inspection shall be removed from the system. If ASME BPE is indicated in the PSAT, then Chapter X of ASME B31.3 is implied for weld and/or brazed inspection. For piping systems indicated as ASME B31.3 or ASME BPE, utilize the appropriate chapter based on the classified fluid service indicated in the PSAT.

The interior of all welds or brazing performed in a shop environment shall be inspected.

ASME BPE Specific Requirements

Examinations shall be performed and documented by the installation contractor per BPE.

The exterior of all welds shall be visually examined by a Level II qualified inspector and documented in the weld log. Welds that do not pass examinations shall either be removed from the system, or re-welded in accordance with ASME BPE-2014 section MJ-6.4.2.

Inspections shall be performed and documented by a qualified 3rd party, separate from the installation contractor. If ASME BPE is indicated in the PSAT, then Chapter X of ASME B31.3 is implied for weld inspection. For piping systems indicated as ASME B31.3, utilize the appropriate chapter based on the classified fluid service indicated in the PSAT.

The interior of welded joints shall be inspected using a borescope. All borescope inspections shall be electronically recorded, and copies of the recordings shall be provided to the Owner. Welds that do not pass examinations shall either be removed from the system, or re-welded in accordance with ASME BPE-2014 section MJ-6.4.2.

The inspection plan by the inspection contractor shall include no less than 20% borescope of the welds in each system installed. Initially, the interior of all welds performed in the field shall be inspected. After an individual welder performs 25 consecutive welds with no rejections, the weld interior inspection rate may be reduced to the minimum agreed upon with Owner but no less than 20%.
Each of the minimum 20% borescope welds shall have video capture as documentation of that inspected weld.

Upon rejection of any weld, the weld interior inspection rate shall increase to all welds, and the accepted weld count shall be reset to zero.

If it is physically impossible to perform a borescope inspection of a weld, an actual configuration coupon (butt-butt coupon) weld just prior to and after completing the blind weld shall be performed, and subsequently inspected for approval or rejection by the weld inspector.

The interior of brazed joints shall be direct visual inspected per BPE code. The Owner and Contractor shall agree upon a minimum percentage of brazed joints for inspection.

4.2.3. **Weld/Brazing Examinations**

All piping system examinations shall satisfy the applicable code as indicated in the PSAT and shall be performed by the installation contractor.

END OF SECTION
<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
<th>Spec</th>
<th>Material</th>
<th>Jacket</th>
<th>Index Temp. (°F)</th>
<th>Test Pressure (psig)</th>
<th>Insulation Spec Data Sheet</th>
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<td>CHWS</td>
<td>Carbon Steel</td>
<td>Insulation</td>
<td>40 - 60</td>
<td>ASME 31.9</td>
<td>40</td>
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<td>Domestic Cold Water</td>
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<td>Copper</td>
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<td>Heating Hot Water Return</td>
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<td>Carbon Steel</td>
<td>Insulation</td>
<td>251 - 350</td>
<td>ASME 31.9</td>
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</table>
PRESSURE AND TEMPERATURE RATING:

0 psig pressure, 180°F maximum temperature.

PIPING:

General Service weight hubless cast iron soil pipe in accordance with ASTM A888, CISPI Standard 301 and bearing the collective trademark of CISPI and be listed by NSF International. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.

FITTINGS:

General Hubless type, service weight, dimensions and tolerances according to ASTM A888, CISPI Standard 301 and bearing the collective trademark of CISPI and be listed by NSF International.

GASKETS:

Hubless Couplings shall be banded couplings with neoprene in accordance with ASTM A1277 and CISPI 310 and be listed by NSF International. Couplings used below grade shall be heavy duty type couplings.

JOINTS:

Compression joints in accordance with the recommendations in the CISPI Standard 310 or “Cast-Iron Soil Pipe and Fittings Handbook”, Chapter IV.
PRESSURE AND TEMPERATURE RATING:

150 psig maximum pressure, -20°F Minimum, 300°F Maximum temperature limit.

PIPING:

General 2” - Under Carbon steel, ASTM A53, Gr. B, seamless or ERW, schedule 40, ASME B36.10M.

2-1/2” – 10” Carbon steel, ASTM A53, Gr. B, ERW, schedule 40, ASME B36.10M.

12” – 24” Carbon steel, ASTM A53, Gr. B, ERW, Class STD weight, ASME B36.10M.

FITTINGS:

General 2” - Under Malleable iron, ASTM A197 or A47, threaded, ASME B16.3, Class 150, ASME B1.20.1.

2-1/2” – 24” Carbon steel fittings, ASTM A 234 Gr. WPB, seamless or welded, butt weld, ASME B16.9, to match pipe schedule.

All natural gas piping connections concealed or above hard ceilings shall be back welded.

UNIONS AND FLANGES:

General 2” - Under Malleable iron union, ASME B1.20.1, threaded, ASME B16.39, Class 150 hexagonal stock, metal-to-metal bronze seats.

2-1/2” – 24” Forged carbon steel flanges, ASTM A 105, weld-neck type, Class 150, ASME B16.5, raised face, bore to match pipe schedule. (Slip-on flanges may be used under special conditions with approval of Owner)

PIPE JOINTS AND BRANCH CONNECTIONS:

General Comply with Branch Construction Chart

GASKETS:

General All sizes General Services - Garlock Blue-Gard Style 3300, 1/8 in. thick, ASME I

Natural/LP Gas/Fuel Oils - Garlock Blue-Gard Style 3000, 1/8 in. thick. ASME B16.21

BOLTING:

Heavy hex head machine bolts, per ASTM A 193-B7, with heavy hex nuts per ASTM A 194 – 2H. Provide ASTM F436 hardened washers under bolt heads and nuts.
### VALVES:

**General**

For all valve types the working pressure and temperature ratings shall comply with ASME B16.34.

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Body</th>
<th>Finish</th>
<th>Disc</th>
<th>Stem</th>
<th>Seats</th>
<th>Packing</th>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate 2” - Under</td>
<td>MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem</td>
<td>Mill</td>
<td>Bronze, solid wedge</td>
<td>Silicon bronze, ASTM B371</td>
<td>Bronze integral</td>
<td>Aramide fibers with graphite packing</td>
<td>Threaded</td>
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<td>MSS SP-128, Class 150, ductile iron, ASTM A395, bolted bonnet, OS&amp;Y</td>
<td>Mill</td>
<td>Ductile Iron, solid wedge</td>
<td>Stainless Steel ASTM A276</td>
<td>Stainless steel</td>
<td>PTFE braided</td>
<td>Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10</td>
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<tr>
<td>Ball ¼” - ½”</td>
<td>MSS SP-110, 600 psi CWP, bronze, ASTM B584, two piece</td>
<td>Mill</td>
<td>316 stainless steel, full port, vented</td>
<td>316 stainless steel, blowout proof</td>
<td>Carbon-filled PTFE</td>
<td>Threaded</td>
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<tr>
<td></td>
<td>MSS SP-110, 600 psi CWP, bronze, ASTM B584, UNS C84400 three piece</td>
<td>Mill</td>
<td>316 stainless steel, full port, vented</td>
<td>316 stainless steel, blowout proof</td>
<td>Reinforced PTFE</td>
<td>Threaded</td>
<td></td>
</tr>
</tbody>
</table>

**Use for pressure gauge isolation only.**

**Manufacturer:** Nibco T-134, or approved equivalent

**2” – Under**

**Manufacturer:** Nibco T-585-70-66T, or approved equivalent

**Body:** MSS SP-110, 600 psi CWP, bronze, ASTM B584, UNS C84400 three piece

**Finish:** Mill

**Ball:** 316 stainless steel, full port, vented

**Stem:** 316 stainless steel, blowout proof

**Operator:** Hand lever operator, plastic coated

**Seats:** Reinforced PTFE

**Connections:** Threaded

**Manufacturer:** Nibco T-595-Y-66, Apollo 82-140, or approved equivalent

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**CRB Consulting Engineers, Inc.**

**Issue Date:** 03/16/17
Butterfly  2½” - 12”  (Non-steam use)  

**Body:** MSS SP-67, 200 psi, ductile iron, ASTM A536, full lug type  
**Finish:** Mill  
**Disc:** Aluminum Bronze ASTM B148  
**Stem:** 416 stainless steel  
**Operator:** Hand lever, lockable (6” and below), Gear (8”-12”)  
**Seats/Liner:** EPDM, molded-in  
**Connections:** Lugged type for dead end service.  

**Manufacturer:** Nibco LD-2000, or approved equivalent  

**14” - 24”**  

**Body:** MSS SP-67, 150 psi, ductile iron, ASTM A536, full lug type  
**Finish:** Mill  
**Disc:** Aluminum Bronze ASTM B148  
**Stem:** 416 stainless steel  
**Operator:** Gear operator  
**Seats/Liner:** EPDM, cartridge style  
**Connections:** Lugged type for dead end service  

**Manufacturer:** Nibco LD-1000-5, or approved equivalent  

Globe  2” – Under  

**Body:** MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem  
**Finish:** Mill  
**Disc:** Steam rated PTFE, steam rated  
**Stem:** Silicon bronze, ASTM B371  
**Seats:** Integral  
**Packing:** Aramid fibers w/ graphite  
**Connections:** Threaded  

**Manufacturer:** Nibco T-235-Y, or approved equivalent  

**2-1/2” – 10”**  

**Body:** MSS SP-85, Class 150, ductile iron, ASTM A395, bolted bonnet, OS&Y  
**Finish:** Mill  
**Disc:** Bronze ASTM B584 or Ductile Iron with Bronze Face rings  
**Stem:** Brass, ASTM B371  
**Seats:** Bronze  
**Packing:** PTFE, braided  
**Connections:** Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10  

**Manufacturer:** Nibco F-738-31, or approved equivalent
Check 2" - Under  
Body: MSS SP-80, Class 150, bronze, ASTM B62, horizontal swing type, Y-pattern, screwed bonnet  
Finish: Mill  
Disc: Bronze, renewable disc and seat  
Connections: Threaded  
Cracking Press.: Manufacturer’s standard  
Manufacturer: Nibco T-433-B, or approved equivalent

2-1/2" - 12"  
Body: MSS SP-136, Class 150, ductile iron, ASTM A395, horizontal swing type, bolted bonnet  
Finish: Mill  
Disc: Bronze  
Connections: Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10  
Cracking Press.: Manufacturer’s standard  
Manufacturer: Nibco F-938-31, or approved equivalent

Lift Check 2-1/2" - 24"  
Body: MSS SP-125, Class 250, cast iron, ASTM A126, Class B, lift check type.  
Finish: Mill  
Disc: Bronze  
Connections: Flanged ASME B16.5, flat face, face to face dimensions ASME B16.10  
Cracking Press.: ½ psi  
Manufacturer: Nibco F-960-B, or approved equivalent

Wafer Check 2-1/2" - 24"  
Body: Class 150, ductile iron, ASTM A536, duo disc wafer check type  
Finish: Mill  
Disc: Aluminum bronze with stainless steel spring  
Connections: Wafer style  
Cracking Press.: Manufacturer’s standard  
Manufacturer: Apco series 9000, or approved equivalent

Gas Cocks 2" – Under  
Body: 200 psi WOG, cast iron, ASTM A126, straightaway pattern  
Finish: Mill  
Plug: Bronze ASTM A126, wrench operated  
Packing: Glass filled TFE  
Connections: Threaded  
Manufacturer: Resun series 1430, or approved equivalent
3” – 12”

**Body:** 200 psi WOG, cast iron, ASTM A126, straightaway pattern

**Finish:** Mill

**Plug:** Cast iron, ASTM A126

**Packing:** Glass filled TFE

**Connections:** Flanged ASME B16.5, flat face, face to face dimensions ASME B16.10

**Manufacturer:** Resun series 1431, or approved equivalent

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### BRANCH CONSTRUCTION CHART

<table>
<thead>
<tr>
<th>BRANCH SIZE</th>
<th>HEADER SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
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<tr>
<td>W</td>
<td>20</td>
</tr>
<tr>
<td>W</td>
<td>24</td>
</tr>
</tbody>
</table>

**TRANSPARENT**

**HEADER SIZE**

- E Reducing Tee
- R Threadolet
- T Straight Tee
- W Weldolet

---

END OF CS03
PRESSURE AND TEMPERATURE RATING:

125 psig maximum pressure, -20°F Minimum, 350°F Maximum temperature limit.

PIPING:

General 2” - Under Carbon steel, ASTM A53, Gr. B, seamless or ERW, schedule 40, ASME B36.10M.

2-1/2” – 10” Carbon steel, ASTM A53, Gr. B, ERW, schedule 40, ASME B36.10M.

12” – 24” Carbon steel, ASTM A53, Gr. B, ERW, Class STD weight, ASME B36.10M.

FITTINGS:


2-1/2” – 24” Carbon steel fittings, ASTM A 234 Gr. WPB, seamless or welded, butt weld, ASME B16.9, to match pipe schedule.

UNIONS AND FLANGES:

General 2” - Under Malleable iron union, ASME B1.20.1, threaded, ASME B16.39, Class 150 hexagonal stock, metal-to-metal bronze seats.

2-1/2” – 24” Forged carbon steel flanges, ASTM A 105, weld-neck type, Class 150, ASME B16.5, raised face, bore to match pipe schedule. (Slip-on flanges may be used under special conditions with approval of Owner)

PIPE JOINTS AND BRANCH CONNECTIONS:

General Comply with Branch Construction Chart

GASKETS:

General All sizes General Services - Garlock Blue-Gard Style 3300, 1/8 in. thick, ASME B16.21

BOLTING:

Heavy hex head machine bolts, per ASTM A 193-B7, with heavy hex nuts per ASTM A 194 – 2H. Provide ASTM F436 hardened washers under bolt heads and nuts.
VALVES:

General For all valve types the working pressure and temperature ratings shall comply with ASME B16.34.

Gate 2" - Under

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish:</td>
<td>Mill</td>
</tr>
<tr>
<td>Disc:</td>
<td>Bronze, solid wedge</td>
</tr>
<tr>
<td>Stem:</td>
<td>Silicon bronze, ASTM B371</td>
</tr>
<tr>
<td>Seats:</td>
<td>Bronze integral</td>
</tr>
<tr>
<td>Packing:</td>
<td>Aramid fibers with graphite packing</td>
</tr>
<tr>
<td>Connections:</td>
<td>Threaded</td>
</tr>
</tbody>
</table>

Manufacturer: Nibco T-134, or approved equivalent

2-1/2" – 24"

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-128, Class 150, ductile iron, ASTM A395, bolted bonnet, OS&amp;Y</th>
</tr>
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<tbody>
<tr>
<td>Finish:</td>
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</tr>
<tr>
<td>Disc:</td>
<td>Ductile Iron, solid wedge</td>
</tr>
<tr>
<td>Stem:</td>
<td>Stainless Steel ASTM A276</td>
</tr>
<tr>
<td>Seats:</td>
<td>Stainless steel</td>
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<tr>
<td>Packing:</td>
<td>PTFE braided</td>
</tr>
<tr>
<td>Connections:</td>
<td>Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10</td>
</tr>
</tbody>
</table>

Manufacturer: Nibco F-637-33, or approved equivalent

Ball ¼" - ½"

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-110, 600 psi CWP, bronze, ASTM B584, two piece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish:</td>
<td>Mill</td>
</tr>
<tr>
<td>Ball:</td>
<td>316 stainless steel, full port, vented</td>
</tr>
<tr>
<td>Stem:</td>
<td>316 stainless steel, blowout proof</td>
</tr>
<tr>
<td>Operator:</td>
<td>Hand lever operator, plastic coated</td>
</tr>
<tr>
<td>Seats:</td>
<td>Carbon-filled PTFE</td>
</tr>
<tr>
<td>Connections:</td>
<td>Threaded</td>
</tr>
</tbody>
</table>

Use for pressure gauge isolation only.

Manufacturer: Nibco T-585-70-66T, or approved equivalent

2" – Under

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-110, 600 psi CWP, bronze, ASTM B584, UNS C84400 three piece</th>
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</thead>
<tbody>
<tr>
<td>Finish:</td>
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<tr>
<td>Ball:</td>
<td>316 stainless steel, full port, vented</td>
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<tr>
<td>Stem:</td>
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<tr>
<td>Operator:</td>
<td>Hand lever operator, plastic coated, lockable</td>
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<tr>
<td>Seats:</td>
<td>Reinforced PTFE</td>
</tr>
<tr>
<td>Connections:</td>
<td>Threaded</td>
</tr>
</tbody>
</table>

Manufacturer: Nibco T-595-Y-66, Apollo 82-140, or approved equivalent
Butterfly  
2½” - 12” (Non-steam use)  
Body: MSS SP-67, 200 psi, ductile iron, ASTM A536, full lug type  
Finish: Mill  
Disc: Aluminum Bronze ASTM B148  
Stem: 416 stainless steel  
Operator: Hand lever, lockable (6” and below), Gear (8”-12”)  
Seats/Liner: EPDM, molded-in  
Connections: Lugged type for dead end service  
Manufacturer: Nibco LD-2000, or approved equivalent

14” - 24”  
Body: MSS SP-67, 150 psi, ductile iron, ASTM A536, full lug type  
Finish: Mill  
Disc: Aluminum Bronze ASTM B148  
Stem: 416 stainless steel  
Operator: Gear operator  
Seats/Liner: EPDM, cartridge style  
Connections: Lugged type for dead end service  
Manufacturer: Nibco LD-1000-5, or approved equivalent

Globe  
2” - Under  
Body: MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem  
Finish: Mill  
Disc: Steam rated PTFE, steam rated  
Stem: Silicon bronze, ASTM B371  
Seats: Integral  
Packing: Aramid fibers w/ graphite  
Connections: Threaded  
Manufacturer: Nibco T-235-Y, or approved equivalent

Globe  
2-1/2” - 10”  
Body: MSS SP-85, Class 150, ductile iron, ASTM A395, bolted bonnet, OS&Y  
Finish: Mill  
Disc: Bronze ASTM B584 or Ductile Iron with Bronze Face rings  
Stem: Brass, ASTM B371  
Seats: Bronze  
Packing: PTFE, braided  
Connections: Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10  
Manufacturer: Nibco F-738-31, or approved equivalent
Check  2" - Under

- Body: MSS SP-80, Class 150, bronze, ASTM B62, horizontal swing type, Y-pattern, screwed bonnet
- Finish: Mill
- Disc: Bronze, renewable disc and seat
- Connections: Threaded
- Cracking Press.: Manufacturer’s standard

Manufacturer: Nibco T-433-B, or approved equivalent

2-1/2” - 12”

- Body: MSS SP-136, Class 150, ductile iron, ASTM A395, horizontal swing type, bolted bonnet
- Finish: Mill
- Disc: Bronze
- Connections: Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10
- Cracking Press.: Manufacturer’s standard

Manufacturer: Nibco F-938-31, or approved equivalent

Lift Check  2-1/2” - 24”

- Body: MSS SP-125, Class 250, cast iron, ASTM A126 Class B, lift check type.
- Finish: Mill
- Disc: Bronze
- Connections: Flanged ASME B16.5, flat face, face to face dimensions ASME B16.10
- Cracking Press.: ½ psi

Manufacturer: Nibco F-960-B, or approved equivalent

Wafer Check  2-1/2” - 24”

- Body: Class 150, ductile iron, ASTM A536, duo disc wafer check type
- Finish: Mill
- Disc: Aluminum bronze with stainless steel spring
- Connections: Wafer style
- Cracking Press.: Manufacturer’s standard

Manufacturer: Apco series 9000, or approved equivalent

Gas Cocks  2” – Under

- Body: 200 psi WOG, cast iron, ASTM A126, straightaway pattern
- Finish: Mill
- Plug: Bronze ASTM A126, wrench operated
- Packing: Glass filled TFE
- Connections: Threaded

Manufacturer: Resun series 1430, or approved equivalent
3" – 12"

Body: 200 psi WOG, cast iron, ASTM A126, straightaway pattern
Finish: Mill
Plug: Cast iron, ASTM A126
Packing: Glass filled TFE
Connections: Flanged ASME B16.5, flat face, face to face dimensions ASME B16.10

Manufacturer: Resun series 1431, or approved equivalent

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**BRANCH CONSTRUCTION CHART**

<table>
<thead>
<tr>
<th>HEADER SIZE</th>
<th>BRANCH SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>T</td>
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<tr>
<td>R</td>
<td>24</td>
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<tr>
<td>T</td>
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<td>1/2</td>
</tr>
<tr>
<td>R</td>
<td>1/4</td>
</tr>
</tbody>
</table>

**HEADER SIZE**

E Reducing Tee
R Threadolet
T Straight Tee
W Weldolet

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END OF CS05
PRESSURE AND TEMPERATURE RATING:

125 psig maximum pressure, -20°F Minimum, 350°F Maximum temperature limit.

PIPING:

General 2” - Under  Carbon steel, ASTM A53, Gr. B, seamless or ERW, schedule 80, ASme B36.10M.

2-1/2” – 8”  Carbon steel, ASTM A53, Gr. B, ERW, schedule 80, ASME B36.10M.

10” – 24”  Carbon steel, ASTM A53, Gr. B, ERW, Class XS weight, ASME B36.10M.

FITTINGS:

General 2” - Under  Cast iron, ASTM A126 Class A, threaded, ASME B16.4, Class 125, ASME B120.1.

2-1/2” – 24”  Carbon steel fittings, ASTM A 234 Gr. WPB, seamless or welded, butt weld, ASME B16.9, to match pipe schedule.

UNIONS AND FLANGES:

General 2” - Under  Malleable iron union, ASME B120.1, threaded, ASME B16.39, Class 150 hexagonal stock, metal-to-metal bronze seats.

2-1/2” – 24”  Forged carbon steel flanges, ASTM A 105, weld-neck type, Class 150, ASME B16.5, raised face, bore to match pipe schedule. (Slip-on flanges may be used under special conditions with approval of Owner)

PIPE JOINTS AND BRANCH CONNECTIONS:

General  Comply with Branch Construction Chart

GASKETS:

General  All sizes  General Services - Garlock Blue-Gard Style 3300, 1/8 in. thick, ASME B16.21

BOLTING:

Heavy hex head machine bolts, per ASTM A 193-B7, with heavy hex nuts per ASTM A 194 – 2H. Provide ASTM F436 hardened washers under bolt heads and nuts.
VALVES:

General

For all valve types the working pressure and temperature ratings shall comply with ASME B16.34.

Gate

2" - Under

Body: MSS SP-80, Class 150, bronze, ASTM B62, union
bonnet, rising stem
Finish: Mill
Disc: Bronze, solid wedge
Stem: Silicon bronze, ASTM B371
Seats: Bronze integral
Packing: Aramid fibers with graphite packing
Connections: Threaded

Manufacturer: Nibco T-134, or approved equivalent

2-1/2" – 24"

Body: MSS SP-128, Class 150, ductile iron, ASTM A395,
bolted bonnet, OS&Y
Finish: Mill
Disc: Ductile Iron, solid wedge
Stem: Stainless Steel ASTM A276
Seats: Stainless steel
Packing: PTFE braided
Connections: Flanged ASME B16.5, raised face, face to face
dimensions ASME B16.10

Manufacturer: Nibco F-637-33, or approved equivalent

Ball

1/4" - 1/2"

Body: MSS SP-110, 600 psi CWP, bronze, ASTM B584,
two peice
Finish: Mill
Ball: 316 stainless steel, full port, vented
Stem: 316 stainless steel, blowout proof
Operator: Hand lever operator, plastic coated
Seats: Carbon-filled PTFE
Connections: Threaded

Use for pressure gauge isolation only.

Manufacturer: Nibco T-585-70-66T, or approved equivalent

2" – Under

Body: MSS SP-110, 600 psi CWP, bronze, ASTM B584,
UNS C84400 three peice
Finish: Mill
Ball: 316 stainless steel, full port, vented
Stem: 316 stainless steel, blowout proof
Operator: Hand lever operator, plastic coated, lockable
Seats: Reinforced PTFE
Connections: Threaded

Manufacturer: Nibco T-595-Y-66, Apollo 82-140, or approved
equivalent
Globe 2” – Under

Body: MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem
Finish: Mill
Disc: Steam rated PTFE, steam rated
Stem: Silicon bronze, ASTM B371
Seats: Integral
Packing: Aramid fibers w/ graphite
Connections: Threaded

Manufacturer: Nibco T-235-Y, or approved equivalent

2-1/2” – 10”

Body: MSS SP-85, Class 150, ductile iron, ASTM A395, bolted bonnet, OS&Y
Finish: Mill
Disc: Bronze ASTM B584 or Ductile Iron with Bronze Face rings
Stem: Brass, ASTM B371
Seats: Bronze
Packing: PTFE, braided
Connections: Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10

Manufacturer: Nibco F-738-31, or approved equivalent

Check 2” - Under

Body: MSS SP-80, Class 150, bronze, ASTM B62, horizontal swing type, Y-pattern, screwed bonnet
Finish: Mill
Disc: Bronze, renewable disc and seat
Connections: Threaded
Cracking Press.: Manufacturer’s standard

Manufacturer: Nibco T-433-B, or approved equivalent

2-1/2” - 12”

Body: MSS SP-136, Class 150, ductile iron, ASTM A395, horizontal swing type, bolted bonnet
Finish: Mill
Disc: Bronze
Connections: Flanged ASME B16.5, raised face, face to face dimensions ASME B16.10
Cracking Press.: Manufacturer’s standard

Manufacturer: Nibco F-938-31, or approved equivalent

Lift Check 2-1/2” - 24”

Body: MSS SP-125 Class 250, cast iron, ASTM A126 Class B, lift check type.
Finish: Mill
Disc: Bronze
Connections: Flanged, flat face, face to face dimensions ASME B16.10
Cracking Press.: ½ psi

Manufacturer: Nibco F-960-B, or approved equivalent
Wafer Check  2-1/2" - 24"  
Body:  Class 150, ductile iron, ASTM A536, duo disc wafer check type
Finish:  Mill
Disc:  Aluminum bronze with stainless steel spring
Connections:  Wafer style
Cracking Press.:  Manufacturer’s standard

Manufacturer:  Apco series 9000, or approved equivalent

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**BRANCH CONSTRUCTION CHART**

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**HEADER SIZE**

- **E** Reducing Tee
- **P** Branch weld w/ reinforcing pad (Pad thickness equals run pipe thickness. Pad width equals ½ branch OD.)
- **R** Threadolet
- **T** Straight Tee
- **W** Weldolet

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END OF CS06
PRESSURE AND TEMPERATURE RATING:

150 psig maximum pressure, 250°F maximum temperature.

TUBING:

General 4" - Under Copper, ASTM B88, hard drawn, seamless, Type L. Tubing used in potable water systems shall be NSF 61 certified, and lead free (< 0.25% lead by weight on wetted parts.)

FITTINGS:

General 4" - Under Wrought copper, pressure fittings, solder joint ends, ANSI B16.22. Fittings used in potable water systems shall be NSF 61 certified, and lead free (< 0.25% lead by weight on wetted parts.)

UNIONS AND FLANGES:

Union 2" - Under Bronze, ANSI B16.22, solder joint.


Flanges 2-1/2" - 4" Bronze, flat face, ANSI 16.24, solder joint, Class 150, ANSI B16.11. Provide dielectric flange kit when joining to dissimilar metal.

Unions and flanges used in potable water systems shall be NSF 61 certified, and lead free (< 0.25% lead by weight on wetted parts.)

PIPE JOINTS AND BRANCH CONNECTIONS:

General Use Branch Construction Chart

Solder/Brazing Lead-free solder ANSI/ASTM B-32 Alloy Grade 95-5 TA, or Phos-copper brazing alloy.

GASKETS:

General All sizes Garlock Stress Saver 6800 EPDM full face, 1/8 in. thick, ANSI B 16.21.

BOLTING:

Heavy hex head machine bolts, per ASTM A193 B8, with heavy hex nuts ASTM A194 G8. Provide 18-8 stainless steel flat washers under bolt heads and nuts.
VALVES:

General For all valve types the working pressure and temperature ratings shall comply with ANSI B16.34. Valves used in potable water systems shall be identified as NSF 61 certified and lead free (< 0.25% lead by weight on wetted parts).

Potable Water System Valves (conform to NSF 61)

Gate 2” - Under

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-139, Class 150, silicon bronze, ASTM B584, screw-in bonnet, rising stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish:</td>
<td>Mill</td>
</tr>
<tr>
<td>Disc:</td>
<td>Silicon Bronze, solid wedge</td>
</tr>
<tr>
<td>Stem:</td>
<td>Silicon bronze</td>
</tr>
<tr>
<td>Packing:</td>
<td>Aramid fibres with graphite</td>
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<tr>
<td>Seats:</td>
<td>Renewable</td>
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<tr>
<td>Connections:</td>
<td>Solder ends</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>Nibco S-111-LF, or approved equivalent</td>
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</tbody>
</table>

Ball: 2” – Under

<table>
<thead>
<tr>
<th>Body:</th>
<th>MSS SP-110, 600 psi, silicon bronze ASTM B584, three piece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish:</td>
<td>Mill</td>
</tr>
<tr>
<td>Ball:</td>
<td>316 stainless steel, vented, full port</td>
</tr>
<tr>
<td>Stem:</td>
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<tr>
<td>Seats:</td>
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<tr>
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Non-Potable System Valves

Gate 2” - Under

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<th>Body:</th>
<th>MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem</th>
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<tr>
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<tr>
<td>Disc:</td>
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<tr>
<td>Stem:</td>
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<tr>
<td>Seats:</td>
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<td>Packing:</td>
<td>Aramid fibres with graphite</td>
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<tr>
<td>Connections:</td>
<td>Solder ends</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>Nibco S-134, or approved equivalent</td>
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</table>
Ball: 2” – Under
Body: MSS SP-110, 600 psi, bronze ASTM B584, three piece
Finish: Mill
Ball: 316 stainless steel, vented, full port
Stem: 316 stainless steel, blow-out proof
Operator: Vinyl covered steel handle
Seats: PTFE seat
Connections: Solder ends
Manufacturer: Nibco series S-595-Y-66, or approved equivalent

Globe 2” – Under
Body: MSS SP-80, Class 150, bronze, ASTM B62, union bonnet, rising stem
Finish: Mill
Disc: Steam rated PTFE
Stem: Silicon bronze
Seats: Integral, renewable
Packing: Aramide fibres with graphite
Connections: Solder ends
Manufacturer: Nibco S-235-Y, or approved equivalent

Potable or Non-Potable System Valves (conform to NSF 61)

Butterfly 2½” - 4”
Body: MSS SP-67, 200 psi, ductile iron, ASTM A536, full lug type
Finish: Mill
Disc: aluminum bronze
Stem: 416 stainless steel, extended neck
Operator: Hand lever operator
Seats/Liner: EPDM, molded-in
Connections: For installation between ANSI class flanges, or bi-directional deadend service
Manufacturer: Nibco LD-2000, or approved equivalent

Swing Check 2” - Under
Body: MSS SP-139, 200 psi, silicon bronze, ASTM B584, horizontal swing type, screwed or bolted bonnet, y-pattern
Finish: Mill
Disc: Bronze, integral seat
Connections: Solder ends
Cracking Press.: Manufacturer’s standard
Manufacturer: Nibco S-413-Y-LF, or approved equivalent
### Check 2 1/2" - 4"

**Body:** MSS SP-80, Class 125, cast iron, ASTM 126, spring actuated type,

**Finish:** Mill

**Disc:** Bronze

**Seat:** Buna-N bonded to bronze

**Connections:** Flange, flat-faced

**Cracking Press.:** Manufacturer’s standard

**Manufacturer:** Nibco F-910-LF, or approved equivalent

### Lift Check 2" – Under

**Body:** MSS SP-139, 250 psi CWP, bronze, ASTM B584, in-line lift check type.

**Finish:** Mill

**Disc:** Resilient discs with PTFE seats and stainless steel springs

**Connections:** Solder ends

**Cracking Press.:** Manufacturer’s standard

**Manufacturer:** Nibco S-480-Y-LF, or approved equivalent

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#### BRANCH CONSTRUCTION CHART

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<th>BRANCH SIZE</th>
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<tr>
<td>E</td>
<td>T</td>
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<tr>
<td>Reducing Tee</td>
<td>Straight Tee</td>
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</table>

**END OF CU01**
PRESSURE AND TEMPERATURE RATING:

150 psig maximum pressure, 350°F maximum temperature.

GENERAL:

Tubing, fittings, and valves shall be factory sealed with end caps. Tubing and fittings shall meet the applicable requirements of the latest edition of the ASME Bioprocessing Equipment Standard (BPE).

For compressed gases, in accordance with CGA G4.1, all tubing, fittings, gaskets and valves shall be cleaned, packaged and identified for use in oxygen services.

FINISH:

Tubing, Fittings
ID: Non-polished.
OD: Non-polished.

TUBING:

Material
ASTM A269 Stainless steel, Type 316L, bright annealed, tubing with a maximum Rockwell hardness number of 90 and a cold worked weld seam.

¼” to 3/8” Seamless, ASTM A269, 0.035” wall thickness.
½” to 1” Seamless or welded seam, ASTM A269, 0.065” wall thickness.

FITTINGS:

Material
Stainless steel, Type 316L, annealed. Wall thickness shall match tubing specifications.

End Connections
Compression ¼” to 1” Swagelok or approved equal. All components of compression fittings shall be of the same manufacturer.

Clamp All Sizes Sanitary clamp end suitable for clamps as specified in this section.

For tubing ¾” and smaller, instead of using fittings, tubing may be bent using approved tube bending tools to achieve changes in direction.

CLAMPS:

General ½”, ¾” Stainless steel, Type 304, polished, heavy duty, single-pin, Alfa-Laval/Triclover 13MHHS-3/4-S, or approved equal.

1” Stainless steel, Type 304, polished, heavy duty, double-pin, Alfa-Laval/Triclover 13MHHM or approved equal. Three segment clamps also permissible up to 4”, Alfa-Laval/Triclover 13MHHS or approved equal.

GASKETS:

General USP Class VI, molded o-ring type for sanitary clamp fittings.
Materials

Continuous Clean Steam Applications Only:
Mixture of 50% PTFE and 50% passivated 316L SS powder. Rubber Fab “TUF-STEEL”, or Newman “SILVERBACK”. Rated to 400°F continuous service.

Hot Water (WFI or Purified Water) Applications Only:
PTFE grafted elastomer. Rubber Fab “TUF-FLEX”. Rated to 400°F continuous service.

All Other Applications:
EPDM. Newman 42RX-E for ½” and ¾”; Newman 40RX-E for 1” through 6”. Rated to 350°F continuous service.

JOINTS AND BRANCH CONNECTIONS:

General
Comply with Branch Construction Chart

Compression type fittings, unless otherwise specified or shown on the drawings.

VALVES:

General
All valves of the same type shall be provided by the same manufacturer for this project. Contractor or Manufacturer shall allow for selection of any of the listed vendors at a later date.

Ball ½” to 1”
Body: Three-piece, ASTM A351 CF3M cast, 316L stainless steel, bolted design.
Finish: Surface finishes shall match tubing and fitting surface finish specifications.
Ball: 316 Series forged stainless steel. Balls shall have ID identical to ID of tubing.
Stem: 316 Series stainless steel. Provide with stem extension where piping is insulated, live loaded, blow-out proof.
Operator: Hand lever operator, “T” handle on 3” and larger.
Seats: Reinforced PTFE seats, and Fluorocarbon FRM body seats
Connections: Valves shall have compression end connections.
Manufacturer: PBM Series 9, or approved equivalent

Poppet Check ½” to 1”
Body: 316 Stainless steel, with Viton seals.
Finish: Surface finishes shall match tubing and fitting surface finish specifications.
Poppet: 316 Stainless steel, 300 series spring.
Connections: Compression ends
Cracking Press.: 1/3 psi
Manufacturer: Swagelok CH style, or approved equivalent
Pinch: ½” to 1”

Body: 125 psig, PEEK, fully drainable, autoclavable

Element: EPDM pinch tube element, with nylon reinforcement stainless steel spring. FDA Compliance with 21 CFR 177.2600.

Finish: Surface finishes shall match tubing and fitting surface finish specifications.

Connections: Valves shall have sanitary clamp end connections unless otherwise indicated on the drawings.

Manufacturer: Aquasyn (ARTeSyn) Arterial Process Valves, or approved equivalent

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**BRANCH CONSTRUCTION**

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**HEADER SIZE**

E  Reducing Tee
T  Straight Tee

END OF SS03
SECTION 230510

HYDRONIC SYSTEM SPECIALTIES

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

Drawings and the general provisions of the contract, including general and supplementary conditions of Div 01 specification sections, apply to this section.

1.2. SUBMITTALS

Product data for each item specified here-in.

1.3. QUALITY ASSURANCE

ASME B 31.9 “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 01.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, provide hydronic piping system specialties from one of the following acceptable manufacturers listed for specialty item.

2.2. FLEXIBLE CONNECTORS

2.3. SPECIAL DUTY VALVES

2.3.1. Calibrated Balancing Valves (Circuit Setters)

2.3.2. Automatic Flow Control Valves

2.3.3. Combined Pressure/Temperature Safety Valves

2.3.4. Pressure Safety Valves

2.4. HYDRONIC SPECIALTIES

2.4.1. Cast Bronze Y-Strainers (1/2” – 2”)

2.4.2. Cast Iron Y-Strainers (2-1/2” and larger)

2.4.3. Basket Strainers

2.4.4. Manual Air Vent

PART 3. - EXECUTION

3.1. VALVE APPLICATIONS

3.2. HYDRONIC SPECIALTIES INSTALLATION
2.2. FLEXIBLE CONNECTORS

Length: Flexible connector length shall be at least four (4) times pipe diameter.

2" and Smaller: Corrugated hose and braided exterior sleeve; Stainless steel for steel piping; Bronze for Copper piping.

3" and Larger: 304 stainless steel corrugated hose and braid and with carbon steel flanged end connections for steel piping; bronze flanges for copper piping. Minimum rated working pressure of 150 psig at 200°F and working temperature range of 0°F to 250°F. Capable of 1” static and 3/4” dynamic offset from centerline minimum.

Acceptable Manufacturers

   Metraflex
   Flexonics
   Hyspan
   Amber Booth

2.3. SPECIAL DUTY VALVES

2.3.1. Calibrated Balancing Valves (Circuit Setters)

Rated working pressure of 125 psig, and temperature of 240°F. Bronze body, plug or ball valve, with calibrated orifice, differential pressure meter connections with integral check valves and seals, integral pointer, and degree of valve opening calibrated scale. End connections; 2" and smaller, threaded; 2-1/2" and larger, flanged.

Valves shall be provided with molded insulation to permit access for balancing.

Acceptable Manufacturers

   Bell & Gossett ITT; Fluid Handling Division
   Nexus Valve
   Nibco
   Flow Design, Inc.

2.3.2. Automatic Flow Control Valves

Brass body valve with stainless steel removable flow cartridge and working pressure rating of 150 psig and temperatures to 250°F. Factory set to automatically control design flow rates ± 5%, while compensating for system operating pressure differential.

Furnished with valve kit consisting of 1/4” x 2” size nipples, quick disconnect inlet/outlet connections, and fittings for flow measuring instrument connection. Provide metal identification tag with chain, factory marked with zone identification, valve model number, and rated flow. End connections: 2” and smaller, threaded; 2-1/2” and larger, flanged.

Control valves shall be provided with ball valves and NOT globe valves.

Acceptable Manufacturer(s)

   Nexus Valve
   Griswold Controls
   Flow Design, Inc.
2.3.3. **Combined Pressure/Temperature Safety Valves**

Provide combined pressure/temperature safety valves as indicated. Valves shall have a permanently mounted tag, indicating manufacturer, model number, serial number, pressure/temperature settings, and rated discharge capacity.

Valves shall be tested for proper operation, prior to installation, and provided with a certification form, indicating conformance to test and to applicable ASME standard.

**Acceptable Manufacturers**

- Watts Regulator Company
- Spirax Sarco
- Bell & Gossett ITT; Fluid Handling Division

2.3.4. **Pressure Safety Valves**

Provide pressure safety valves as indicated. Valves shall have a permanently mounted tag, indicating manufacturer, model number, serial number, pressure settings, and rated discharge capacity.

Valves shall be tested for proper operation, prior to installation, and provided with a certification form, indicating conformance to test and to applicable ASME standard.

**Acceptable Manufacturers**

- Watts Regulator Company
- Spirax Sarco
- Bell & Gossett ITT; Fluid Handling Division

2.4. **HYDRONIC SPECIALTIES**

2.4.1. **Cast Bronze Y-Strainers (1/2” – 2”)**


**Acceptable Manufacturers**

- Mueller
- Keckley
- Nibco

2.4.2. **Cast Iron Y-Strainers (2-1/2” and larger)**

Class 250, cast iron body (ASTM A126-B), type 304 stainless steel screen (0.062” perforations for 2-1/2”-4” piping and 0.125” perforations for piping larger than 4”), self-cleaning design and furnished with blowdown tapping piped to ball valve and threaded outlet cap. End connections: Flanged. ANSI B16.1.

**Acceptable Manufacturers**

- Mueller
- Armstrong International
- Hoffman Specialty
2.4.3. **Basket Strainers**

Simplex Class 150, cast carbon steel (ASTM A216) body and bolted or swing-clamp cover, type 304 stainless steel screen with manufacturer’s standard perforation size.

For strainers installed in 4” and larger piping, include drain tapping in body piped to ball valve and threaded outlet cap. End connections: 2” and smaller, threaded; 2-1/2” and larger, flanged. Seals shall be EPDM [Viton]. Include accessory magnetic basket insert.

**Acceptable Manufacturers**

- Mueller
- Armstrong International
- Eaton Filtration
- Keckley

2.4.4. **Manual Air Vent**

Rated working pressure of 150 psig, and temperature of 225°F. Bronze or brass body, nonferrous internal parts, discharge connection copper tube pig-tail, and manually operated with screwdriver or thumbscrew. 1/2” ball valves may be used in lieu of manual air vents.

**PART 3. - EXECUTION**

Install hydronic system specialties as shown on the drawings, and in accordance with manufacturer's instructions and recommendations. Install in a location readily accessible for maintenance and inspection.

3.1. **VALVE APPLICATIONS**

Install calibrated balancing valves and automatic flow control valves on the outlet of each heating or cooling element and elsewhere as shown.

3.2. **HYDRONIC SPECIALTIES INSTALLATION**

Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as indicated for system air venting.

Install y-pattern and basket strainers in supply branch piping ahead of control valves, heating / cooling coils, heat exchangers, and elsewhere as required to protect control and heat transfer equipment. Provide startup screens in all strainers and replace with final screens after the system has been flushed.

**END OF SECTION**
SECTION 230520

STEAM SYSTEM SPECIALTIES

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specification sections, apply to this section.

1.2. QUALITY ASSURANCE

ASME B 31.9 “Building Services Piping”: For materials, products, and installation.

ASME “Boiler and Pressure Vessel Code”: Section IX, “Welding and Brazing Qualification” for qualifications for welding processes and operators.

Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.3. SUBMITTALS

Product Data: Submit product data for each item included. Submit calculations and sizing data for all pressure reducing valves and safety relief valves.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide steam and condensate piping system specialties from one of the following:
2.2. **STEAM TRAPS**

**Float and Thermostatic Traps:** Cast-iron body and bolted cap conforming to one of the following: ASTM A126 Class B, A278 Class 30, or A48 Class 30. Renewable, stainless steel float mechanism, with renewable stainless steel valve and seat; balanced pressure thermostatic air vent made of renewable stainless steel or bronze element with renewable stainless steel valve and seat.

**Thermodynamic Traps:** Stainless steel body with screwed cap, stainless steel disc and seat, maximum operating pressure 600 psig.

**Inverted Bucket Traps:** Case-iron body and cap rated for 250 psi working pressure and conforming to one of the following: ASTM A126 Class B, A278 Class 30, or A48 Class 30. Stainless steel head and seat; stainless steel valve retainer, lever, guide pin assembly, and stainless steel bucket.

2.3. **AIR VENTS**

**Thermostatic Air Vents:** Manufacturer’s standard body material, with balanced pressure beryllium copper, phosphor bronze, stainless steel, or monel thermostatic bellows, and stainless steel heads and seats. 300 psig rating.

**Float-Thermostatic Air Vents:** Cast-iron or brass body; balance pressure thermostatic bellows; replaceable stainless steel seat, float, and head. 35 psig rating.

2.4. **VACUUM BREAKERS**

**Vacuum Breakers:** Brass or stainless steel body, brass or stainless steel ball or stem type valve, EPR o-ring seal, and minimum ½” threaded system connection. 300 psig rating.

2.5. **STRAINERS**

**Y-Pattern Strainers:** Minimum 250 psig steam working pressure.
15 psig or below:  Cast-iron body conforming to ASTM A48 Class 30 or A126 Class B, type 304 stainless steel screen (maximum 30 mesh for 2" and smaller, and manufacturer recommended for sizes 2-1/2" and larger); tapped blow-off for gate valve, and threaded nipple.  End connections; 2" and smaller threaded, 2-1/2" and larger flanged.

Above 15 psig:  Cast carbon steel body conforming to ASTM A216, Grade WCB, type 304 stainless steel screen (maximum 30 mesh for 2" and smaller); tapped blow-off for gate valve, and threaded nipple.  End connections: 2" and smaller socket weld, 2-1/2" and larger flanged.

2.6.  PRESSURE REDUCING VALVES

Pilot-actuated, diaphragm type, adjustable pressure range, and positive shut-off; steel body, hardened stainless steel trim, and replaceable valve head and seat.  Main head stem guide fitted with flushing and pressure arresting device, noise attenuator, and covered standard pilot regulator.  There shall be no springs in the steam path, or stuffing boxes.  Connections shall be flanged for 2-1/2" and larger, and threaded for 2" and under.

PART 3. - EXECUTION

3.1.  SPECIALTIES INSTALLATION

Install steam system specialties as shown on the drawings, and in accordance with manufacturer's instructions and recommendations.  Install in a location readily accessible for maintenance and inspection.

3.2.  STEAM TRAP INSTALLATIONS

Install steam traps as close as possible, but no greater than four (4) feet to connected equipment.

3.3.  PRESSURE SAFETY VALVE INSTALLATIONS

Install relief valves in accordance with and where required by ASME B 31.1 “Power Piping” and as indicated on drawings and comply with ASME Boiler and Pressure Vessel Code.  Pipe discharge to atmosphere outside the building, without stop valves, with gooseneck and screened vent cap or vent head with drip piping.  Install a drip pan elbow fitting adjacent to the safety valve discharge and pipe drain connection to the nearest floor drain without valves.

END OF SECTION
SECTION 230810

HUMIDIFIERS

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

This Section includes humidifier panels, manifolds, steam generating equipment and associated controls and accessories.

1.3. SUBMITTALS

Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, pressure drops, absorption distances, heat losses and electrical characteristics.

Shop Drawings: Diagram power, signal, and control wiring.

Field quality-control test reports.

Operation and Maintenance Data: Provide operation, and maintenance manuals.

1.4. QUALITY ASSURANCE

Codes and Standards

ARI Compliance: Test and rate humidifiers in accordance with ARI 610 "Standard for Performance rating of Central Steam Humidifiers."

ARI Compliance: Install humidifiers in accordance with ARI 630 "Standard for Selection, Installation, and Servicing of Humidifiers."

Project No. 162848.00

230810 - 1 of 3

Humidifiers

Rev. A, 03/16/17

Issue for Bid
ARI Compliance: Test and rate humidifiers in accordance with ARI 640 "Standard for Performance rating of Commercial and Industrial Humidifiers."

UL and NEMA Compliance: Provide electrical components required as part of humidifiers, which are listed and labeled by UL and comply with NEMA Standards.

NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of humidifiers.

PART 2. - PRODUCTS

2.1. MATERIALS AND COMPONENTS

General: Except as otherwise indicated, provide humidifiers and ancillary equipment with manufacturer's standard materials and components as indicated by published product information, designed and constructed by manufacturer for complete installation.

2.2. SELF-CONTAINED STEAM HUMIDIFIERS

General: Provide self-contained steam humidifiers of size and capacity as indicated in the attached datasheets.

Steam Generator: Provide electrode type boiler, with cleanable and replaceable electrodes, designed to produce steam at atmospheric pressure, with modulating control. Provide one (1) extra set of electrodes for humidifier.

Distribution: Provide stainless steel duct distribution pipes and connecting steam hose.

Electrical: Provide one (1) common connection for electrical supply to electrical disconnect switch. Provide indicator lights to show unit status. Humidifier shall incorporate electrical factory wired terminals for installation of controls.

Cabinet: Provide steel cabinet to house steam generator and controls. Design for wall mounting with hinged lockable door, and baked enamel finish. Provide connections for water, drain, and electricity.

Drain Cycle: Provide automatic drain cycle and electronic timer, field adjustable for both drain duration and drain interval.

Air Gap: Provide air gap on water fill line in accordance with plumbing code having jurisdiction.

Controls: Furnish solid-state electronic sensor controller (humidistat) capable of full modulation. Provide high-limit humidistat. Provide interlock switch to fan motor and/or to sail switch in duct to shut down unit upon airflow failure.

Acceptable Manufacturers: Subject to compliance with requirements, provide self-contained steam humidifiers by one of the following:

- Dri-Steem Humidifier Co.
- Armstrong, Inc.
- Herrmidifier Co., Inc.
- Nortec Industries, Inc.
PART 3. - EXECUTION

3.1. INSTALLATION OF HUMIDIFIERS

General: Install humidifiers where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that humidifiers comply with requirements and serve intended purposes.

Access: Provide access space around humidifiers for service as indicated, but in no case less than that recommended by manufacturer.

Support: Provide supports from substrate for humidifiers as indicated and in accordance with manufacturer's installation instructions.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

Verify that electrical wiring installation is in accordance with submittal data.

Ductwork Connections: Provide airtight seal at each penetration of humidifiers into ductwork. Provide access door as recommended by manufacturer for service.

Steam Piping Connections: Provide separate valve branch to supply humidifier from top of dripped steam runout, unless otherwise shown or noted.

Makeup Water and Drain Connections: Provide separate valve branch to supply humidifier. Provide backflow prevention device as indicated. Adjust automatic drain down with timer.

Grounding: Provide electrical equipment ground for electrically operated humidifiers and components.

3.2. FIELD QUALITY CONTROL

Upon completion of installation and prior to initial operation, test and demonstrate that air humidification equipment is leak-tight.

Repair or replace air humidification equipment as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.3. ADJUSTING AND CLEANING

Startup: Start-up humidifiers in accordance with manufacturer's instructions.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION
Description: Humidifiers
Layout Drawing No.: Equipment No.: HUM-5000
P&I Diagram No.: 

DESCRIPTION

Manufacturer: VS * Model No.: VS *
Type: 
\[ \square \text{Jacketed} \quad \square \text{Direct Injection} \]
\[ \square \text{Self-Contained} \quad \square \text{Evaporative Pan} \]
\[ \square \text{Manifold} \quad \square \text{Ultra-Sonic} \]

CODES AND STANDARDS

\[ \square \text{UL} \quad \square \text{ANSI} \quad \square \text{AHRI} \quad \square \text{ASHRAE} \quad \square \text{ASTM} \quad \square \text{NEC} \]

SERVICE CONDITIONS AND PERFORMANCE REQUIREMENTS

Airflow ACFM: See Schedule on Plans Installed Elevation: 1000 Ft.
Steam Operating Pressure: 15 Psig Above Sea Level
Electrical Power Supply: 208 V 3 PH 60 HZ

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<td>Electrical Power Consumption</td>
<td>See Schedules kW</td>
<td>See Schedules kW</td>
</tr>
</tbody>
</table>

Max. / Actual Dispersion Tube Spacing: 6 / VS * inches
Humidifier Connection Size: VS *

CONSTRUCTION

Casing Material: Stainless Steel
Distribution Tube Material: Stainless Steel
Piping Connections: Opposite Ends
Pipe Connection Type: Threaded
Trap Type: Float Thermostatic
Control Valve:
Control Signal:

VS * - Vendor/Manufacturer to Supply Information

<table>
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<tr>
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<th>D. Hale</th>
<th>Checked by</th>
<th>D. Peterson</th>
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<td>Page 1 of 2</td>
</tr>
</tbody>
</table>
Description: **Humidifiers**

---

**VENDOR FURNISHED CONTROLS**

- Control Humidity Sensor
- Hi-Limit Humidity Sensor
- Alarm Fault
- Flow Switch
- Drain and Makeup Water Control
- Control Panel
- Temperature Switch
- Microprocessor
- Local Display
- BMS Interface

---

**REMARKS:**

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**VS * - Vendor/Manufacturer to Supply Information**

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Project No. 162848.00  
Issue Date: 03/16/17  
Page 2 of 2
SECTION 230855

CUSTOM AIR HANDLING UNITS

INDEX

PART 1. - GENERAL

1.1. SCOPE

Custom air handling units shall be designed and manufactured to the requirements of the specifications, data sheets, and drawings for this project.

The AHU shall be designed with shipping splits and to be field disassembled with ease to accommodate the unit’s required installation path into the building.

The manufacturer shall supervise the reassembly of the AHU by the installing contractor.

1.2. QUALITY ASSURANCE

NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling unit(s).

Units shall be produced by a recognized manufacturer who maintains a local service agency and parts stock.

Air handling units and major components shall be products of manufacturing firms regularly engaged in production of such equipment whose products have been in satisfactory use in similar service for not less than five (5) years.

Fans shall conform to AMCA bulletins regarding testing and construction.

Coils shall be ARI certified.

Filter media shall be UL listed.

PART 2. - PRODUCTS

2.1. CUSTOM AIR HANDLING UNITS

PART 3. - EXECUTION

3.1. SEQUENCING AND SCHEDULING

3.2. GENERAL REQUIREMENTS

3.3. DELIVERY, STORAGE AND HANDLING

3.4. INSTALLATION OF AIR HANDLING UNITS

3.5. FIELD QUALITY CONTROL

3.6. EXTRA FILTER STOCK
Units with factory wiring shall be factory UL/ETL/CSA approved and labeled.

Failure to comply with this requirement will necessitate the manufacturer, at his expense, to have a certified UL/ETL/CSA representative inspect the equipment prior to affixing a label.

1.3. SUBMITTALS

Product data shall include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gauges and material finishes.

The submittal shall provide all technical information relevant to the product being provided, including but not limited to, all the information shown in the attached data sheet(s).

It is the responsibility of the supplier to highlight any variances the equipment has with the requirements of this specification whether or not pre-approval has been obtained.

Information shall be provided in the same measurement units as indicated in the data sheet(s).

The submittal(s) shall provide independent fan curves for operating/design conditions [not fan tables], with specified operating/design points clearly plotted.

The submittal(s) shall provide coil selection worksheets, clearly showing proper consideration for altitude, air density, glycol corrections and indicate coil tube fin and casing construction.

The submittal(s) shall provide filter information, including: initial (clean) APD, final (dirty) APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, and filter removal details.

The manufacturer shall submit sound power levels for both air handling unit inlet, outlet and radiated at rated capacity.

The manufacturer shall submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

The manufacturer shall submit the manufacturer’s recommended installation instructions.

Omission of any of the above information will cause shop drawings to be immediately returned without review.

1.4. OPERATION AND MAINTENANCE DATA

The manufacturer shall submit operation and maintenance data.

The manufacturer shall include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5. WARRANTY

A warranty shall be provided by the manufacturer for the air handling unit(s). Contractor shall assume manufacturer’s warranty in its entirety, as if the equipment had been purchased by the Contractor.

It shall be the responsibility of the Contractor, during the term of the warranty, to respond to reports of evident malfunction or failure, as though the equipment had been furnished by him, conduct the necessary diagnostic efforts, and if the malfunction is deemed by him to be the manufacturer’s warranty liability, to so resolve this responsibility with the manufacturer as the Owner’s agent.
PART 2.- PRODUCTS

2.1. CUSTOM AIR HANDLING UNITS

Refer to attached data sheet(s) for requirements.

2.2. ACCEPTABLE MANUFACTURERS

Specified manufacturers and approved equivalent manufacturers are as follows:

- Temtrol
- Climate Craft
- Energy Labs
- Haakon

Special Note: The Engineer may reject any equipment item or accessory which in his opinion is not of the type or quality specified in data sheet(s) or drawings.

PART 3.- EXECUTION

3.1. SEQUENCING AND SCHEDULING

Coordinate with the air handling unit manufacturer's representative and provide assistance as necessary for start-up services.

3.2. GENERAL REQUIREMENTS

Contractor shall take full responsibility for the air handling unit(s). This includes removal from delivery truck, storing at a location acceptable to the Owner (if needed before installation), moving into place, setting, and installing in accordance with the manufacturer’s installation requirements, and all other work required to put air handling unit(s) into operation.

The manufacturer shall provide the factory assembled air handling unit in configuration as indicated on the data sheets and drawings. The unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted unless prior approval in writing from the Engineer/Owner.

Units too large to be legally shipped by truck may be shipped to the site in sections. Otherwise units shall be shipped in one piece.

3.3. DELIVERY, STORAGE AND HANDLING

Protect fabricated casings, accessories and purchased products from damage during storage and handling. Prevent end damage and prevent dirt and moisture from entering duct connection openings and fittings.

Handle air handling unit(s) carefully to avoid damage to components, enclosures and finish. Do not install damaged components. Replace and return damaged components to air handling unit manufacturer for replacement and notify owner.

Comply with Manufacturer's rigging and installation instructions for unloading air handling unit(s), and moving them to final location.
3.4. **INSTALLATION OF AIR HANDLING UNITS**

**General:** Install air handling units where indicated, in accordance with equipment manufacturer’s published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

**Coordination:** Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of air handling units with other work.

**Access:** Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

**Support:** Install floor-mounted air handling units on 4" high reinforced concrete pad, 4" larger on each side than unit base. Mount on neoprene pads as indicated in 230241 – Vibration and Seismic Control.

**Electrical Wiring:** Install electrical devices furnished by manufacturer but not specified to be factory-mounted, according to manufacturer’s directions.

**Piping Connections:** Provide piping, valves, accessories, gauges, supports, and flexible connectors as indicated on drawings.

**Duct Connections:** Refer to Division 23 Ductwork, and Ductwork Accessories sections. Provide ductwork, accessories, and flexible connections as indicated on drawings.

**Grounding:** Provide positive equipment ground for air handling unit components. Provide motor shaft grounding of all AHU motors.

**Control Components:** Install control components to be supplied by controls contractor indicated to be located in the air handling unit sections. Coordinate with Controls contractor.

3.5. **FIELD QUALITY CONTROL**

**Coordination:** The manufacturer will provide the services of a factory authorized service representative to start the units and instruct the Owner’s personnel in proper operation of the units. Coordinate with the manufacturer’s representative.

3.7. **PERFORMANCE TESTS**

Perform a full field performance test of each supply air handling unit. Provide a written report to the Owner showing all performance data and certifying compliance with the specification requirements.

Coordinate with the air handling unit manufacturer for replacement of all components which do not meet the performance specifications. Control devices shall not be installed for factory tests.

Field tests shall be witnessed by Engineer of Record and/or Owner Representative.

Field Leakage Test: Perform leakage test of each supply air handling unit in the field after installation using the criteria noted below.

Units shall be tested with all BAS components installed.
Temporary modifications of any kind, caulking, lubricant, tape (other than what is noted below), or other items employed to assist units to pass factory testing are not allowed.

1. Cover and thoroughly seal all duct and piping connections.
2. Isolate and test Air Handler under a negative pressure of 10” wg.
3. Record casing leakage (CFM) value for unit.
4. Report results in writing signed by contractor and factory authorized representative.

The allowed leakage rate field tests for the Air Handler shall be calculated using the following formula.

\[ C_{LC} = CL \times (P^{0.65}) \]

\[ C_{LC} = \text{Calculated Allowed Leakage Rate (CFM/100 ft}^2) \]
\[ CL = \text{Casing Leakage Rate} = 6 \]
\[ P = \text{Pressure (in w.g.)} \text{ – 10”} \]

The recorded leakage rate shall not be larger than the maximum allowed leakage rate of 1.5% of design airflow (cfm). If this occurs then corrective measures shall be undertaken by the manufacturer of the Air Handler.

3.6. EXTRA FILTER STOCK

The manufacturer will provide one extra set of each filter type for the air handling unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from testing and balancing contractor that new filters have been installed.

END OF SECTION
SECTION 230855  CUSTOM AIR HANDLING UNITS

Description: Custom Air Handling Unit
Layout Drawing No.: Equipment No.:
P&I Diagram No.: Enclosures:

DESCRIPTION

Manufacturer: VS *  Model No.: VS *  Size: VS *
Unit Design: ☐ Single Zone  ☒ Cabinet and Base  ☐ Lighting  ☐ Power
☐ Mixing Box  ☐ Filters  ☐ Pre-heat Coil(s)
☐ Cooling Coil(s)  ☐ Heating Coil(s)  ☐ Damper(s)
☐ Humidifier(s)  ☐ Plug Fan(s)  ☐ Internal Sound Attenuator
☐ Desiccant Dehumidification  ☐ Indoor Construction  ☐ Other

Max. AHU Overall Dim.: 240"L x 120"W x 108"H  Actual AHU Overall Dim.: VS * x VS * x VS *
Maximum AHU Weight: 10,000 Lbs.  Actual AHU Weight: VS *

CODES AND STANDARDS

☐ AMCA  ☒ AHRI  ☒ ASHRAE
☐ ASTM  ☐ ANSI  ☐ NEC (latest edition)

SERVICE CONDITIONS AND PERFORMANCE REQUIREMENTS

Installed Elevation: 1000 Ft. Above Sea Level

Pre-Filters
Manufacturer: Camfil Farr  Model No.: 3030  Size: 24" x 24" or 24"x20"
Efficiency: 30-35% ASHRAE  Clean/Dirty PD.: .10/.75 "wc  Qty.: VS *

Final Filters
Manufacturer: Camfil Farr  Model No.: Rigi-Flo  Size: 24" x 24" or 12" x 6"
Efficiency: 80-85% ASHRAE  Clean/Dirty PD.: .40/1.25 "wc  Qty.: VS *

HEPA Filters
Manufacturer: Camfil Farr  Model No.: VS *  Size: 24" x 24" or 12" x 4"
Efficiency: 99.97% Scanned  Clean/Dirty PD.: .80/1.25 "wc  Qty.: VS *

NOTE: Provide air handling unit mounted magnehelic gauge for each filter bank.

Preheat Coil Section
Coil Steam Operating Pressure: 15 Psig

<table>
<thead>
<tr>
<th>Design Condition</th>
<th>Operating Condition</th>
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</thead>
<tbody>
<tr>
<td>See Schedules MBH</td>
<td>See Schedules MBH</td>
</tr>
<tr>
<td>See Schedules acfm</td>
<td>See Schedules acfm</td>
</tr>
<tr>
<td>See Schedules °F</td>
<td>See Schedules °F</td>
</tr>
<tr>
<td>See Schedules °F</td>
<td>See Schedules °F</td>
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<tr>
<td>See Schedules Lb/hr</td>
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<tr>
<td>/ Ft. Hd.</td>
<td>/ Ft. Hd.</td>
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VS * - Vendor/Manufacturer to Supply Information

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<td>Project No. 162848.00</td>
<td>Issue Date: 03/16/17</td>
<td>Page 1 of 8</td>
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CRB Consulting Engineers, Inc.
**SECTION 230855**

**CUSTOM AIR HANDLING UNITS**

**Description:** Custom Air Handling Unit

**Equipment No.:** AHU-5000

<table>
<thead>
<tr>
<th>Max. / Actual Air Pressure Drop:</th>
<th>0.4 / VS * &quot;wc</th>
<th>0.4 / VS * &quot;wc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. / Actual Coil Face Velocity:</td>
<td>800 / VS * Fpm</td>
<td>800 / VS * Fpm</td>
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</table>

<table>
<thead>
<tr>
<th>Max. / Actual FPI:</th>
<th>10 / VS *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coil Connection Sizes:</td>
<td>VS *</td>
</tr>
<tr>
<td>Coil Quantity:</td>
<td>1</td>
</tr>
</tbody>
</table>

**Cooling Coil Section**

Ent. Water Temp./Lvg. Water Temp.: **44 / 56 °F**

| Total Capacity: | See Schedules MBH |
| Sensible Cooling Capacity: | See Schedules MBH |
| Airflow: | See Schedules acfm |
| Entering Air Temperature (db/wb): | See Schedules °F |
| Leaving Air Temperature (db/wb): | See Schedules °F |
| Water Flow Rate: | See Schedules Gpm |
| Max. / Actual Water Pressure Drop: | 10 / VS * Ft. Hd. |
| Max. / Actual Air Pressure Drop: | 1.4 / VS * "wc |
| Max. / Actual Coil Face Velocity: | 500 / VS * Fpm |

<table>
<thead>
<tr>
<th>Max. / Actual FPI:</th>
<th>10 / VS *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coil Connection Sizes:</td>
<td>VS *</td>
</tr>
<tr>
<td>Coil Quantity:</td>
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</table>

**Steam Pre-Heat Coil Section**

Ent. Water Temp./Lvg. Water Temp.: **160 / 120 °F**

| Total Capacity: | See Schedules MBH |
| Sensible Cooling Capacity: | See Schedules MBH |
| Airflow: | See Schedules acfm |
| Entering Air Temperature: | °F |
| Leaving Air Temperature: | °F |
| Water Flow Rate: | Gpm |
| Max. / Actual Water Pressure Drop: | 10 / VS * Ft. Hd. |
| Max. / Actual Air Pressure Drop: | 1.4 / VS * "wc |
| Max. / Actual Coil Face Velocity: | 500 / VS * Fpm |

<table>
<thead>
<tr>
<th>Max. / Actual FPI:</th>
<th>10 / VS *</th>
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<tbody>
<tr>
<td>Coil Connection Sizes:</td>
<td>VS *</td>
</tr>
<tr>
<td>Coil Quantity:</td>
<td>1</td>
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</table>

**Humidifier Section**

Acceptable Manufacturers: Nortec, Dri-Steam, Armstrong

Actual Manufacturer, Model, & Size: VS *

Steam Operating Pressure: 12 Psig

**VS * - Vendor/Manufacturer to Supply Information**

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CRB Consulting Engineers, Inc.
Description: Custom Air Handling Unit

Total Capacity: See Schedules Lbs/hr
Airflow: See Schedules acfm
Entering Air Temperature: See Schedules °F

Max./Act. Vapor Trail: 3 / VS * Ft. Number of Manifolds: VS *
Manifold Length: VS * Manifold Spacing: VS *
Orifice Size: VS * Ratio of Max:Min: VS *
Control Valve Size: VS * Control Valve Range: VS *
Actuator Type: Electric Actuator Control Signal: 0-10 Volt
Accessories/Options: ☑ Steam Trap

Supply Fan Section Twin City, New York, Buffalo, Peerless, Cook, Temtrol
Acceptable Manufacturers: VS *
Actual Manufacturer, Model, & Size: VS *

Fan Type: Plug Fan Quantity: 6
AMCA Arrangement: 4 Motor Position: W
Discharge Location: Not Applicable Rotation: Clockwise
Wheel Diameter: VS * Maximum Safe Speed: VS *
Pressure Class: II Max. Safe Oper. Temp.: VS * ° F

Motor Electrical Characteristics: 480 Volt, 3 Phase, 60 Hz. Enclosure: TEAO or TEFC
Motor Design: B Motor RPM: 1800
Minimum Motor Horsepower: 10 Hp Actual Motor Horsepower: VS *
Min. Motor Efficiency: NEMA Premium Actual Motor Efficiency: VS * %
Motor Service Factor: 1.15 Motor Power Factor: 0.85 Minimum
Motor Insulation Class: F Motor Bearings: Permanently Greased
Motor Frame Type: Mfg.'s Std. Motor Frame No.: VS *
Accept. Motor Mfg's: Reliance, Westinghouse, GE, Baldor, Century
Actual Motor Manufacturer: VS * VFD Controlled: Yes

CRB Consulting Engineers, Inc.
SECTION 230855
CUSTOM AIR HANDLING UNITS

Description: Custom Air Handling Unit
Equipment No.: AHU-5000

CONSTRUCTION

General
Base: Manufacturers Standard

Cabinet:
Unit Location Const.: Penthouse Indoor Construction
Structural Support: Manufacturers Standard with Lifting Lugs
Panel Construction: Double Wall, Bolted Gasketed Joints, with Thermal Breaks
Floor Construction: Double Wall, 16 ga., G90 Galv. Stl., Tractor Tread
Roof Construction: Double Wall, 16 ga., G90 Galv. Stl., Roof
Inner Wall Material: Refer to each Section for Inner Wall Material
Insulation: 3" Thick, 3 Lb. Density, Close Cell Foam, 4" Thick Insulation in Floor.
Unit Access: 24" x 72" Access Doors with 12" x 12" Plexiglass Windows in all AHU sections.
Exterior Finish: 2 coat Primer, and Baked Enamel with Owner Selected Color
Interior Finish: 2 coat Primer, and Baked Enamel with Owner Selected Color if applicable
Maximum Housing Leakage Rate: 1.5% of the Total Air Handling Unit CFM at 10 "wc.
NOTE: Access doors shall open against the sections operating pressure.

Mixing Box Section
O.A. Position: Inlet to AHU O.A. Size:
Damper(s) Type: Parallel Blades Damper(s) Manufacturer: VS *
Blade Style: Airfoil Blade Material: Min. 16 ga. Galv. Steel
Frame Material: Min. 16 ga. Galv. Steel Blade Edge Seals: Closed Cell Foam
Axle: Manufacturer Standard Bearings Material:
Air Blender: None Damper(s) Operator: By Others

Filter Section(s)
Gasketing: Closed Cell Foam Filter Holders: Manufacturer Standard

Steam Preheat Coil Section
Manufacturer: VS * Coil Type: Distributing Steam
Casing: 16 ga. Galvanized Steel Piping Connections: Same End
Tube Material: Copper Tube Dia. / Wall Thk.: 1/2" / 0.025"
Fin Material: Aluminum Fin Thk. / Ht. & Wd.: 0.007" / Mfg. Std.
Protective Coating: None Design Pressure Rating: 150 Psig
Coil Test Pressure: 400 Psig Design Temp. Rating: 250 °F

Dampers:
Actuator Power: 24 Volt Actuator Control Signal: Elec. 4-20 mA
Damper Material: Min. 16 ga. Galv. Stl. Damper Location: Before After Coil

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Project No. 162848.00 Issue Date: 03/16/17
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CRB Consulting Engineers, Inc.
Description: Custom Air Handling Unit

Equipment No.: AHU-5000

Rod Material: Copper
Bushing Material: Steel

NOTE: Coil vent and drain connections shall be extended to the unit exterior. Vent and drain connections terminating inside the unit will not be accepted.

Cooling Coil Section

Manufacturer: VS *
Casing: 16 ga. Stainless Steel
Tube Material: Copper
Fin Material: Aluminum
Protective Coating: None
Coil Test Pressure: 400 Psig
Cond. Drain Pan: Stainless Steel, IAQ Rated
Drain Outlet Location: Side Outlet
Drain Outlet Size: 1-1/2"
Actuator Power: Not Applicable

NOTE: Coil vent and drain connections shall be extended to the unit exterior. Vent and drain connections terminating inside the unit will not be accepted.

Humidifier Section

Type: Steam Jacketed
Cond. Drain Pan: Stainless Steel, IAQ Rated
Drain Outlet Location: Side Outlet
Drain Outlet Size: 1-1/2"

NOTE: Manifold shall be factory mounted, all other parts shall be shipped loose for contractor installation

Fan Section(s)


Housing: Not Applicable
Wheel Type: Airfoil
Wheel Options: None
Drive: Direct

Belt drive shall have static conducting "V" belts, rated for 1.5 times the motor horsepower.

Guard: OSHA General
Motor Removal Rail: Supply Fan

Bearings: Mfg.’s Std.
Grounding: Mfg.’s Std.
Seal: Mfg.’s Std.
Inlet: Bell Mouth
Damper Operator: Not Applicable

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Project No. 162848.00  Issue Date: 03/16/17  Page 5 of 8
### Description:
**Custom Air Handling Unit**

**Equipment No.: AHU-5000**

<table>
<thead>
<tr>
<th>Outlet:</th>
<th>Not Applicable</th>
<th>Outlet Damper:</th>
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<tbody>
<tr>
<td>Damper Operator:</td>
<td>Not Applicable</td>
<td>Operator Options:</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Fan Discharge:</td>
<td>None</td>
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</tr>
<tr>
<td>Drain:</td>
<td>Not Applicable</td>
<td>Drain Size:</td>
<td></td>
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<tr>
<td>Housing Access:</td>
<td>Not Applicable</td>
<td>Access Location @ o’clock.</td>
<td>(viewed from outlet end)</td>
</tr>
<tr>
<td>Base:</td>
<td>Mfg.’s Std.</td>
<td>Isolators:</td>
<td>Free Standing Springs</td>
</tr>
<tr>
<td>Miscellaneous:</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Unit Discharge Section
- **Dampers:** Not Applicable
- **Damper Operator:** Not Applicable
- **Outlet Velocity:** 1,200 - 1,500 fpm
- **Outlet Velocity:** Not Applicable
- **Oper Power/Control Signal:**

### Noise At Air Handling Unit's Outlet:
- **Frequency Band:**
  - 63 125 250 500 1000 2000 4000 8000
- **Max. Sound Level:**
  - VS * VS * VS * VS * VS * VS * VS *

### Electrical
- **Lighting:**
  - LED Light One In Each Accessible Section
  - Gang Switched  Individually Switched
- **Receptacle:**
  - One On Outside Surface of Unit, & Separate Equipment Grounds
  - Factory Wired to Lighting Circuit  Field Wired to Individual Circuit
- **Combination Disconnect & Starter on Outside of Unit:**
  - Provide  By Others
- **Non-Fusible Disconnect Switch on Outside of Unit:**
  - Provide  By Others

**NOTES:** Electrical conductors and EMT conduit shall be factory installed and wired. The electrical power service shall be a single point connection at the unit. Junction boxes shall be installed to facilitate conductor splices required for shipment of the unit.

### REMARKS:
1. Provide manufacturer’s one (1) year warranty. Warranty period shall begin at equipment start-up or six months after delivery, whichever occurs first.

2. Provide one (1) extra set of filters for installation by contractor prior to final balancing.

3. Sealants shall be non-sag, non-staining, permanently flexible, of the highest quality and recommended by its manufacturer for the intended application. Sealant (gasket) materials shall not be reactive, additive, or absorbive so as to alter the air (fluid) stream.

4. Unit and components shall be selected for design conditions specified above and then manufacturer shall provide operating performance for unit and components selected.

**VS * - Vendor/Manufacturer to Supply Information**

<table>
<thead>
<tr>
<th>R</th>
<th>Spec. by</th>
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5. Unit shall be fully performance tested at site after installation, for coil performance, housing leakage rate, fan performance, and HEPA DOP tested. Manufacturer shall replace or correct any components not meeting project specifications.

6. Unit manufacturer shall provide a qualified service technician for start-up of unit and to instruct Owner's personnel for a minimum of eight (8) hours on maintenance and operation of unit.

7. Unit shall be thoroughly cleaned to remove all dust, grease, excess sealant, and other debris. All openings shall be sealed airtight prior to shipment.

8. Insulation shall have a flame spread rating of 25 and a smoke developed rating of 50.

9. Provide a flanged connection for all duct connections to the unit (i.e. supply air, outside, air)

10. Units will be located in unconditioned penthouse which will be exposed to outdoor air conditions of 95F db / 75F wb. Design of air handling units shall be such that air handling unit casing will not cause condensation.

11. Each unit/module shall be supplied with four (4) lifting points at a minimum. Manufacturer to provide lifting lugs and bracing for each unit/module.

12. AHU Doors shall be provided with metal access handles, and hinges shall be provided with butt hinges (no piano hinges).

13. VFD shall be unit mounted in a NEMA 12 cabinet and provided with a redundant drive and a transfer switch. Provide with single point power. Reference spec section 262923.
Description: Custom Air Handling Unit  
Equipment No.: AHU-5000

UNIT LAYOUT:

Left Side

Right Side

<table>
<thead>
<tr>
<th>Section #</th>
<th>Section Type</th>
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<tbody>
<tr>
<td>1</td>
<td>Inlet Section</td>
</tr>
<tr>
<td>2</td>
<td>Pre-Filters &amp; Final Filters</td>
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<tr>
<td>3</td>
<td>Steam Pre-Heat Coil</td>
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<tr>
<td>5</td>
<td>Access Section</td>
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<td>6</td>
<td>Cooling Coil Section</td>
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<td>7</td>
<td>Fan Array Sectionw/Access</td>
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<tr>
<td>8</td>
<td>Access Section</td>
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<td>9</td>
<td>HEPA Filter Section</td>
</tr>
<tr>
<td>10</td>
<td>Discharge Section</td>
</tr>
</tbody>
</table>

Side of Unit for Access: Right

Side of Unit for Piping Connections: Right
PART 1 - GENERAL

1.1. QUALITY ASSURANCE

AMCA Compliance: Units shall be rated by AMCA as noted on Data Sheets.

UL Listing: Units shall be UL listed.

1.2. SEQUENCING AND SCHEDULING

Fans shall be delivered to the site and installed in compliance with the overall project schedule.

1.3. DELIVERY, STORAGE AND HANDLING

Protect fans from damage during storage and handling. Prevent end damage and prevent dirt and moisture from entering fans.

Handle fans carefully to avoid damage to components, enclosures and finish. Do not install damaged components. Replace and return damaged components to fan manufacturer.

Comply with Manufacturer's rigging and installation instructions for unloading and moving to final location.

1.4. WARRANTY

Provide warranty in accordance with Section 230010.
PART 2.- PRODUCTS

General: Unless fan's housing is aluminum, stainless steel, or otherwise indicated, prime paint sheet metal parts prior to final assembly and apply final coat of enamel to exterior surfaces after assembly.

2.1. CENTRIFUGAL FANS

General: Provide centrifugal fans of sizes, arrangement, capacities, and accessories as indicated on attached datasheet(s) and as scheduled.

Acceptable Manufacturers: Subject to compliance with requirements, provide products of one (1) of the following:

- Greenheck
- Twin City Fan
- Cook Fan

2.2. UTILITY VENTILATING SETS

General: Provide utility, ventilating sets of sizes, arrangement, capacities, and accessories as indicated on attached datasheet(s) and as scheduled.

Acceptable Manufacturers: Subject to compliance with requirements, provide products of one (1) of the following:

- Greenheck
- Cook Fan
- Twin City Fan

PART 3. - EXECUTION

3.1. INSTALLATION OF FANS

General: Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that fans comply with requirements and serve intended purposes.

Remove shipping bolts and temporary supports. Adjust dampers for free operation.

Access: Provide access and service space around and over fans as indicated, but in no case less than that recommended by manufacturer. Provide access doors in ducts to service dampers.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

Verify that electrical wiring installation is in accordance with manufacturer's directions. Ensure that rotation is in direction indicated and intended for proper performance.

Ductwork Connections: Provide flexible connections on inlet and outlet duct connections.

Vibration Isolation: Set fans on vibration isolators if required by data sheets; fasten in accordance with manufacturer's installation instructions. Vibration isolators are specified in Section 230241.
3.2. **CENTRIFUGAL FANS**

**Support:** Provide 4” high concrete pad under floor-mounted centrifugal fans, if located inside facility.

3.3. **VENTILATOR FANS**

**Support:** Mount units on curbs where indicated. Provide roof curbs to roofing contractor for installing on roof.

3.4. **FIELD QUALITY CONTROL**

Upon completion of installation of fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected.

END OF SECTION
Description: **Centrifugal Fan**

**Equipment No.:** EF-5001-001, 5001-002, 5002-001, 5002-002

P&I Diagram No.: 
Enclosures:

### DESCRIPTION

**Manufacturer:** VS *

**Model No.:** VS *

**Quantity:** 1

**Size:** VS *

### CODES AND STANDARDS

- AMCA Sound
- AMCA Air
- UL
- ISO
- NFPA

### COMPONENTS

- Drive
- Motor
- Screen
- Access Door
- Inlet Damper
- Bellmouth Inlet
- Inlet Vanes
- Vibration Monitoring
- Vibration Isolation
- Base
- Insulation Clips
- Backdraft Damper
- Shaft Seal
- Other
- Drive Guard
- Discharge Damper
- Air Flow Sensor
- Wheel Diameter
- Fan
- Bell Mouth Inlet
- Min. Discharge Velocity
- Screen
- Weatherhood
- Shaft Seal
- Backdraft Damper
- Other

### SERVICE CONDITIONS AND PERFORMANCE REQUIREMENTS

- **Pressure Class:** II
- **Sparkproof Type:** W
- **Arrangement No.:** 4
- **Motor Position:** W
- **Type:** SWSI
- **Rotation:** Clockwise
- **Discharge:** Upblast
- **Wheel Diameter:** VS *
- **Max. Safe Speed:** VS * RPM
- **Min. Safe Oper. Temp.:** VS * °F
- **Max. Safe Oper. Temp.:** VS * °F
- **Material Handled:** Air
- **Installed Elevation:** 1000 Ft Abv Sea Level
- **Capacity:** See Schedules acfm
- **Temp.:** ° F
- **Air Density:** 0.075 Lb/cu. ft.
- **Inlet External Static Pressure:** See Schedules " wc
- **Discharge External Static Pressure:** See Schedules " wc
- **Total External Static Pressure:** See Schedules " wc
- **Velocity Pressure at Fan Outlet:** See Schedules " wc
- **Total Pressure:** See Schedules " wc
- **Fan BHP/RPM:** VS * / VS *

### VS * - Vendor/Manufacturer to Supply Information

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**Issue Date:** 03/16/17  
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CRB Consulting Engineers, Inc.
Description:  Centrifugal Fan

Equipment No.: EF-5001-
001, 5001-002, 5002-001, 5002-002

Mechanical Efficiency:
Sheave Size:

<table>
<thead>
<tr>
<th>VS * %</th>
<th>VS * %</th>
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Location: Outdoors  Elevation: Ft. Above S.L.
Area Classification: General Purpose  Class / Group / Division: NA / NA / NA
Motor Electrical Characteristics: 480 Volt, 3 Phase, 60 Hz.  Enclosure: TEFC
Minimum Motor Horsepower: 1 Hp  Motor RPM: 1800
Actual Motor Horsepower: VS *  Min. Motor Efficiency: NEMA Premium

Motor Frame No.: VS *  Actual Motor Efficiency: VS * %
Motor Manufacturer: VS *  Motor Insulation Class: F
Motor Design: B  Motor Bearings: Permanently Greased
Motor Service Factor: 1.15  Motor Power Factor: 0.85 Minimum

CONSTRUCTION

Housing: Mfg.'s Std.  Housing Material: Carbon Steel
Wheel Type: Backward Inclined
Wheel Options: None  Wheel Material: Carbon Steel
Drive: Direct  Drive Sheave: Fixed

Guard: OSHA General  Guard Options: None
Bearings: Mfg.'s Std.  Bearing Ave. (L50) Life: 200,000 hours
Grounding: Mfg.'s Std.  Shaft: Mfg.'s Std.
Seal: Mfg.'s Std.  Grease Connections: External
Inlet: Plain End  Inlet Damper: None
Inlet Damper Operator: Not Applicable  Operator Options: Not Applicable
Drain: Mfg.'s Std.  Drain Size: 3/4"

Housing Access: Mfg.'s Std.  Access Location @ o’clock. (viewed from outlet end)
Base: Mfg.'s Std.  Isolators: Neoprene Pads

Miscellaneous:

REMARKS:

1. Fan shall be statically and dynamically balanced.

2.

VS * - Vendor/Manufacturer to Supply Information

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CRB Consulting Engineers, Inc.
SECTION 230891 METAL DUCTWORK

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PART 1. - GENERAL

1.1 RELATED DOCUMENTS

In addition to the drawings and general conditions specification for the project, applicable sections of the following documents apply to and comprise part of the document:

1. 230010 “Basic Mechanical Requirements”
2. 230050 “Basic Mechanical Materials and Methods”
3. 230241 “Vibration and Seismic Controls”

1.1 DUCTWORK SIZES

Ductwork sizes indicated on the drawings are “air flow” actual sheet metal dimensions, unless duct is indicated to be lined, and then they are the free area dimensions.

Quality Assurance

2. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.4.4 - "HVAC System Construction and Insulation."
Duct Sealing
1. Seal ducts to the following seal classes according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible":
   a. All Supply, Return, Outside, and Exhaust Ducts: Seal Class A.

1.2. DEFINITIONS

Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

Seams: A seam is defined as joining of two (2) longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two (2) joints. All other duct surface connections made on the perimeter are deemed to be joints.

Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3. SYSTEM PERFORMANCE REQUIREMENTS

The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system.

Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

This Contractor will be held responsible for the coordination between himself and the other contractors for locating and marking of openings for all ductwork, outlets, etc.

All air outlets and other openings of ductwork shall be kept tightly closed during construction to keep the system free of dust and debris.

1.4. DUCTWORK SUBMITTALS

Ductwork submittals shall be prepared and include the following:

1. Sheet metal fabrication drawings at minimum 3/8” = 1’-0” scale.
2. Ductwork material and fabrication standards indicating gauges, seam and joint construction details, reinforcing details and spacing, and fittings for the various pressure classifications required.
3. Sealing materials product data
4. Fire-stopping materials product data
5. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
6. Duct accessories, including access doors and panels

Provide coordination drawings of ductwork in collaboration with all other trades in accordance with specification section 230010.
1.5. **QUALITY ASSURANCE**

**Welding: Qualify Procedures and Personnel**

**SMACNA Standards:** Comply with the following for fabrication and installation of metal ductwork.

1. “HVAC Duct Construction Standards, Metal and Flexible”
2. “Rectangular Industrial Duct Construction Standards”, and “Round Industrial Duct Construction Standards”
3. Comply with SMACNA’s “HVAC Air Duct Leakage Test Manual” for sealing and testing of metal ductwork. Rate ductwork for pressures listed in duct construction table below.


**NFPA Compliance:** Comply with the following:

1. NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems”
2. NFPA 90B “Standard for the Installation of Warm Air Heating and Air Conditioning Systems”
3. NFPA 45 “Standard for Laboratory Exhaust Systems”
4. NFPA 91 “Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids”

**PART 2. - PRODUCTS**

All ductwork shall be protected by end caps, or covering after initial fabrication by factory or shop until installed at site, to prevent inside of ductwork from gathering dust and debris before completed installation. Clean ductwork prior to capping or covering of ductwork.

**2.1. DUCTWORK MATERIALS AND DUCTWORK CONSTRUCTION TABLE**

Provide materials that are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections.

Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A924, with G 90 zinc coating in accordance with ASTM A653.

Shop-fabricate ductwork in 12’ maximum lengths. Construct and reinforce ductwork as indicated in SMACNA’s Standards.

Unless indicated otherwise, use 45° laterals and elbows for branch takeoff connections.

Fabricate duct fittings to match adjoining ducts or equipment and to comply with duct requirements as applicable to fittings. Fabricate radius elbows with minimum centerline radius equal to associated duct width; and include turning vanes in shorter radius elbows are necessary.

Refer to table below for minimum ductwork construction standards. Sheet metal gages and sealing shall be per SMACNA standards for the pressure and leakage classes listed in the following table.
<table>
<thead>
<tr>
<th>Ductwork Location</th>
<th>Pressure Class</th>
<th>Seal Class</th>
<th>Leakage Class</th>
<th>Material</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>AHU-5000 SYSTEM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Main supply from AHU to branch duct</td>
<td>+6</td>
<td>A</td>
<td>2</td>
<td>G-90</td>
<td>1</td>
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<tr>
<td>Branch duct to RHC, CV or VAV boxes</td>
<td>+4</td>
<td>A</td>
<td>2</td>
<td>G-90</td>
<td>1</td>
</tr>
<tr>
<td>RHC, CV or VAV boxes to HEPA terminal outlets</td>
<td>+3</td>
<td>A</td>
<td>4</td>
<td>G-90</td>
<td>1</td>
</tr>
<tr>
<td>RHC, CV or VAV boxes to terminal outlets</td>
<td>+1</td>
<td>A</td>
<td>4</td>
<td>G-90</td>
<td>1</td>
</tr>
<tr>
<td>Humidification section in duct</td>
<td>Match Duct Section</td>
<td>A</td>
<td>2</td>
<td>304 SS</td>
<td>2,3</td>
</tr>
<tr>
<td>Unfiltered terminal inlet return/exhaust to main duct</td>
<td>-1</td>
<td>A</td>
<td>4</td>
<td>G-90</td>
<td>1</td>
</tr>
<tr>
<td>Exhaust main to fan</td>
<td>-2</td>
<td>A</td>
<td>4</td>
<td>G-90</td>
<td>1</td>
</tr>
<tr>
<td>Exhaust from fan to discharge</td>
<td>+1</td>
<td>C</td>
<td>8</td>
<td>G-90</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table Notes**

1. Alternate constructions will be considered provided they are tested in accordance with SMACNA testing standards and approved by the Engineer.
2. No alternate constructions will be considered.
3. Ductwork shall be constructed of stainless steel and continuously welded and pitched back to the humidifier. Provide condensate drain at low point of duct.
   a. Within X'-X" downstream and X'-X" upstream of a duct humidifier.

2.2. **PRE-MANUFACTURED NON-INDUSTRIAL ROUND OR FLAT OVAL DUCTWORK**

**Single Wall Ductwork**

Ductwork shall be rated for positive and negative pressures as indicated in the duct construction table above. All ductwork and fittings shall be factory fabricated by a single manufacturer and supplied by a single company.

**Duct Construction:** Duct of up to 60" diameter shall be spiral wound lock-seam construction. Duct shall be provided in continuous, unjoined lengths to a maximum of 20'-0". All joints unless otherwise indicated up to 36" diameter shall be tight fitting slip type joints with a minimum of 2" insertion length. All joints 36" diameter and above shall be flange connection joints.

**Joints:** Provide beaded sleeve connections, and couplings up to 36" diameter, unless otherwise indicated.
**Fittings and Couplings:** Provide continuous welds along seams.

**Elbow Fittings:** Unless specifically detailed otherwise, use long radius 45°, 3 gore, and long radius 90° 5 gore fittings. Elbow fitting construction, different than those specified, and having lower pressure drop losses as indicated by SMACNA or ASHRAE are acceptable.

**Take-off Fittings:** Unless specifically detailed otherwise, use 45° laterals, 45° boot style tap, high efficiency take-offs for branch takeoff connections and 45° WYE fittings.

Increasing or reducing fittings shall be constructed with a maximum angle of 15° on increasers and 30° on reducers.

**Couplings:** Provide all couplings to connect sections of ductwork, fittings to fittings, and other components together, and to complete the installation of the ductwork system shown.

**Manufacturers:** Subject to compliance with requirements, provide factory-fabricated ductwork, fittings, and couplers of one of the following:

- Semco
- United-McGill
- The Wagner Group Inc.

2.2.1. **Rectangular Duct**

1. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   a. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   b. Deflection: Duct systems shall not exceed deflection limits according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible."
   c. Minimum sheet metal gauge shall not exceed 24 gauge.

2. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   a. Manufacturers:
      - Ductmate Industries, Inc.
      - Ward Industries, Inc.

3. Formed-On Flanges: Construct according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
   a. Manufacturers:
      - Ductmate Industries, Inc.
      - Lockformer.
   b. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
   c. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

4. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area.
2.3. FLEXIBLE DUCTWORK

Flexible ducts shall be round, insulated duct, factory fabricated of a spring steel wire helix or flat steel spiral covered by and bonded to a polymeric or vinyl-coated fiberglass fabric for leak-tight air seal, covered with 1" thick glass fiber insulation and an outside flexible, puncture-resistant and scuff resistant vapor barrier jacket. Duct shall be UL 181 listed, Class I, and shall conform to the requirements of NFPA 90A / 90B. The core material shall not support mold or mildew growth.

Vendor supplied flexible ductwork hanger supports shall be constructed of durable composite material and shall be 1½” wide to prevent any restriction of the internal diameter of the ductwork when the weight of the supported section rest on the hanger. Vendor supplied hanger supports shall be UL listed for used in return air plenum spaces.

Vendor supplied elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6”-16”. Elbow supports shall be UL listed for use in return air plenum spaces.

Acceptable Manufacturers

- Thermaflex
- Genflex
- Flexmaster

Ducts shall be rated for not less than the static pressure listed in the duct construction table above and for air velocities up to 2,500 fpm.

2.4. MISCELLANEOUS DUCTWORK MATERIALS

General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size to comply with ductwork system requirements including proper connection of ductwork and equipment.

Insulation: Insulation of ductwork shall be as indicated in Section 230250 - “Mechanical Insulation.”

Joint and Seam Sealant: One-part, nonsag, water-based fiber-reinforced synthetic latex duct sealant formulated with a minimum of 70 percent solids, 0/0 flame spread/smoke developed, FDA approved/LEED compliant/UL 181 A-M Listed. Sealant shall be Hardcast, Inc. “Versa-Grip 102” duct sealer or approved equal. Sealant shall be used on all shop fabrication and field seams, joints, fastener penetrations, and connections.

Flanged Joint Sealant: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use 0. Mastic shall be used on all flanged field joints. Flange gasketing tape shall be Hardcast, Inc. “A-1104” or Ductmate 440 flange gasketing tape.

Duct Taping: Ductwork shall not be sealed or installed using self-adhesive duct tape. Duct tape is not allowed for any purpose.

Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel hangers, brackets, fasteners, anchors, rods, straps, aircraft wire with clutcher mechanism, trim and angle iron for support of ductwork. Supports for stainless steel ductwork in exposed areas shall be stainless steel. Support spacing and installation shall be in accordance with applicable SMACNA Standards. Screws into ductwork at supports shall not be used, unless prior approval from Owner or Owner’s Representative is given, and then they shall be sealed airtight.
2.5. **FIRE-STOPPING**

Refer to Section 230050 “Basic Mechanical Materials and Methods” for fire-stopping.

**PART 3. - EXECUTION**

3.1. **INSTALLATION OF DUCTWORK**

**General:** Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

**Field Fabrication:** Coordinate field fabrication of round, and rectangular ductwork at project as necessary to match shop-fabricated work and accommodate installation requirements.

**Control Components:** Install all control components in sheet metal equipment or ductwork as shown and/or indicated, including but not limited to automatic and manual control dampers, fire dampers, smoke dampers, temperature sensors or indicators, humidity sensors or indicators, flow sensors, switches, or indicators, freeze stats, static pressure sensors, and end position switches.

**Routing:** Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work. Coordinate with insulator to prevent installation of duct in such a way, that insulator cannot apply insulation.

**Penetrations:** Where ducts pass through interior partitions and exterior walls, seal space between construction opening and duct or duct insulation with sealant and sheet metal flanges of two (2) gauges heavier than duct. Overlap opening on four (4) sides by at least 1-1/2". Fasten to duct and substrate.

Where ducts pass through fire rated floors, walls, or partitions, provide fire dampers, or fire/smoke dampers if indicated and provide firestopping between duct and substrate, as specified in Section “Basic Mechanical Materials and Methods.”

**Duct Supports:** Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts straight, plumb, free of sags and vibration, and to prevent buckling. Support ductwork from building structure where not otherwise indicated, anchor with bolts, concrete inserts, welded studs, C-clamps, or special beam clamps with support as indicated in the SMACNA Standards. Anchor methods other than listed shall receive prior approval from Owner before using. Support vertical ducts, at every floor, 12 foot maximum spacing, by attachment to adjacent vertical structural surfaces or by direct bearing at floor penetrations and similar locations.

**Turning Vanes:** Rectangular tees, bends and elbows shall be provided with turning vanes as specified in Section 230910 “Ductwork Accessories.”

**Balancing Dampers:** Provide manually operated volume dampers, as indicated, to ensure proper balancing and control of air systems, as specified in Section 230910 “Ductwork Accessories.”
3.2. **METAL DUCTWORK**

Sealing: Seal duct seams and joints according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. All ductwork shall be sealed in accordance with duct construction table above. Seal ducts before external insulation is applied.

3.3. **FLEXIBLE DUCTS**

Flexible duct shall only be used where indicated on the drawings. Flexible ductwork will not be allowed anywhere else in the building. The inner liner shall be secured in place to the round duct with nylon or steel draw-bands and sealed for an airtight connection, and then the insulation and outer vapor barrier jacket shall be drawn up to completely cover the connection and shall be secured in place with a second nylon or steel draw-band for a vapor tight connection.

Flexible ducts shall be supported with 2" wide, 20 gauge steel straps. The use of wire for the support of flexible ducts is not acceptable. Where flexible duct is used as a bend or elbow, the included angle or the bend shall not exceed 90 degrees in any plane.

**Maximum Length:** For any duct run using flexible ductwork, do not exceed 5'-0” extended length.

3.4. **EQUIPMENT CONNECTIONS AND BUILDING EXPANSION JOINT LOCATIONS**

**General:** Connect metal ductwork to equipment as indicated, provide flexible connection or rubber gasket at flanged joints for each ductwork connection to equipment mounted on vibration isolators, equipment containing rotating machinery and ductwork crossing building expansion joints. All ductwork crossing the building expansion joints shall be provided with a six inch flex connection. Coordinate exact location of expansion joint with CM.

Provide access doors at all duct mounted components as indicted in the design documents.

Furnish and install all materials and equipment for connection to bio-safety cabinets, autoclaves, washers, canopy hood systems and ovens. Ductwork shall be pitched to provide ample and free drainage of condensate and liquids from ductwork. Provide thimble connections and or open ended ducts as indicated in the design documents.

3.5. **TESTING**

**Leakage Tests:** After each duct system or portion of a duct system is completed, this contractor shall test the section in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. The tests shall verify that the entire duct system for each air handling unit has a total leakage rate as indicated in the duct construction table above. Leakage from non-duct components (fire dampers, smoke dampers, volume control boxes, etc.) are an integral part of overall system leakage, and these components shall be included in duct leakage tests. Contractor shall be responsible for any remedial efforts directed at products in order to bring the system or section into compliance with the leakage rate specified.

Provide all blank off covers, fan connection points, and test holes required. Seal up of all test holes and removal of all covers after section of duct or entire duct system has been tested and approved as acceptable.

By means of a suitable fan and test manometers, the systems shall be pumped up to static pressure indicated on the duct construction table above and held for a period of 10 minutes. After this period the pressure shall be reduced and the duct systems shall be visually and audibly inspected to determine that all joints are tight. After all leaks are properly sealed, the duct shall be repressurized to static pressure indicated as on the duct construction table above and held for 10 minutes and then reduced again and all leaks rechecked. Contractor shall repair leaks and repeat tests until total leakage is as indicated on the duct construction table above.
Contractor is responsible for the costs associated with any retests required due to total system duct leakage greater than indicated in the duct construction table above.

Contractor is responsible for submitting copies of certified calibration data for leakage test apparatus and the reports on the leakage tests. The report shall give an accurate description of the test procedure and results including any remedial action that was needed to obtain an acceptable test. Owner or Owner's Representative shall be present for tests at Owner's discretion.

3.6. **ADJUSTING AND CLEANING**

Remove protective ductwork caps or cover as it is being installed.

Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of all foreign substances.

Clean all ductwork in the project area to be painted with final wipedown with alcohol after installation of individual sections.

Clean in accordance with National Air Duct Cleaners Association (NADCA).

**Temporary Closure:** At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering, which will prevent entrance of dust and debris until time connections are completed.

**Balancing:** This contractor shall provide the initial balancing and adjusting of all air handling systems. All final testing and balancing will be performed by an independent testing and balancing contractor. This contractor shall assist during the final balancing and testing. Refer to Specification Section 230990 “Testing, Adjusting, and Balancing” for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in the balancing process. Volume dampers shall be per project plans and specifications and be suitable (Provide remote adjustment type if required) for area installed.

END OF SECTION
SECTION 230910  DUCTWORK ACCESSORIES

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

Drawings and general provisions of the contract, including general and supplementary conditions and Division
01 specification sections, apply to this section.

1.2. RELATED SECTIONS

Division 28 Section “Fire Detection and Alarm” for duct mounted fire and smoke detectors.
1.3. QUALITY ASSURANCE

SMACNA Compliance: Comply with SMACNA “HVAC Duct Construction Standards, Metal and Flexible”.

Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated. Comply with AMCA 500-D testing for damper rating.

UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 “Fire Dampers and Ceiling Dampers.” Leakage labeled under UL 555S.


1.4. SUBMITTALS

Product Data: For each type of product indicated.

Shop Drawings: Indicate installation details in ductwork and other construction. Provide wiring diagrams.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

General: Ductwork Accessories are specified by manufacturer’s numbers as to type and quality required. Subject to compliance with requirements, provide manufacturers or approved equivalent manufacturer products as indicated.

2.2. DAMPERS

2.2.1. Manual Volume Dampers, Rectangular (For sizes 18”wx10”h and smaller)

Damper frame and blades shall be field fabricated and constructed of the same material as the duct in which it is installed. Dampers shall conform to SMACNA construction standards.

Damper blades shall be constructed with 22 gauge minimum blades. Provide minimum 3/8” square steel end bearings. Provide Ventlock 635 manual locking dial regulator with tamper-resistant hexagonal lock nut, or approved equivalent. For insulated systems provide 2” hand quadrant standoff bracket.

2.2.2. Manual Volume Dampers, Round (For sizes 12”diameter and smaller)

Damper frame and blades shall be field fabricated and constructed of the same material as the duct in which it is installed. Dampers shall conform to SMACNA construction standards.

Dampers shall be constructed with 24 gauge minimum blades but not less than two (2) gages more than the duct gage. Provide minimum 3/8” square steel end bearings. Provide Ventlock 635 manual locking dial regulator with tamper-resistant hexagonal lock nut, or approved equivalent. For insulated systems provide 2” hand quadrant standoff bracket.

2.2.3. Manual Volume Dampers, Rectangular (For sizes 18”wx10”h and larger)

Damper frame and blades shall be factory fabricated. Dampers shall conform to SMACNA construction standards.
Dampers shall consist of a 20 gauge galvanized steel hat channel frame with 5” depth triple V type blades fabricated from 16 gauge galvanized steel; ½” plated steel axles; external (out of the airstream) blade to blade linkage. Testing shall be in accordance with AMCA standard 500. For insulated systems provide 2” hand quadrant standoff bracket. Basis of design is Greenheck model MBD-15.

Acceptable Manufacturers
- Greenheck
- Ruskin

2.2.4. Manual Volume Dampers, Round (For sizes 12” diameter to 24” diameter)

Damper frame and blades shall be factory fabricated. Dampers shall conform to SMACNA construction standards.

Damper shall consist of: a 20 gauge galvanized steel frame with 6” depth; blades fabricated from 20 gauge galvanized steel; 3/8” plated steel axles. Testing and ratings shall be in accordance with AMCA Standard 500. For insulated systems provide 2” hand quadrant standoff bracket. Basis of design is Greenheck model MBDR-50.

Acceptable Manufacturers
- Greenheck
- Ruskin

2.2.5. Bearing Seals

Ventlok, Inc. or approved equal damper bearing seals on all inboard and outboard bearings.

2.2.6. Remote Damper Operators

Young Regulator damper adjustment device, including rod, steel gear operator (Model 927-B), recessed access regulator (Model 301CDS).

2.2.7. Airtight Isolation Dampers

Dampers shall be round flat blade type tested to be (low leak, bubble-tight) per ASME N520-1995.

Construction: The damper shall be manufactured from 11-gauge and 7-gauge T-304 stainless steel sheet metal. The damper shall have 7-gauge stainless steel blades with a silicone gasket to seal against the inside wall of the damper.

The damper shall have 7-gauge flanges on the inlet and outlet with predrilled mounting holes and 1/4” neoprene gasket. The damper shall be adequately reinforced to withstand negative pressure listed in duct construction table in specification section 230891.

All welding procedures, welders and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. Basis of Design is Camfil Farr model 3440R-0103. Provide with locking handle for blade operation. Dampers shall be designed to prevent leakage of gas during room or hood decontamination.

Acceptable Manufacturers
- Camfil Farr
- Baker
- Nuaire
2.2.8. **Rectangular Control Damper**

Damper shall consist of: a 16-gauge galvanized steel channel frame with a 5” depth; opposed blade, airfoil shaped, galvanized steel double skin construction blades (14-gauge equivalent thickness); ½” diameter plated steel axles; extruded silicon rubber or EPDM blade seals; flexible aluminum jamb seals; and external (out of the airstream) blade-to-blade linkage.

Damper shall leak no more then 6 cfm/ft² at 4 inwg. Testing and ratings shall be in accordance with AMCA Standard 500. Provide with 24-volt modulating electric actuator, which uses a 4-20 ma signal. Actuators shall be by Valvcon, Belimo, or approved equivalent. Basis of Design is Greenheck model VCD-33.

**Acceptable Manufacturers**
- Greenheck
- Ruskin
- Air Balance
- Arrow United Industries
- Penn Ventilator

2.2.9. **Round Control Damper**

Dampers shall consist of a round channel frame, single axle, and single circular blade fabricated from 10-gauge steel. Damper axle shall be continuous pivoting in stainless steel sleeve bearings pressed into each side of the damper frame. Provide EPDM seals with blade stops.

Testing and ratings shall be in accordance with AMCA Standard 500. Provide with 24-volt modulating electric actuator, which uses a 4-20 ma signal. Actuators shall be by Valvcon, Belimo, or approved equivalent. Basis of Design is Greenheck model HCDR-150.

**Acceptable Manufacturers**
- Greenheck
- Ruskin
- Air Balance
- Penn Ventilator

2.2.10. **Round Isolation Damper**

Damper shall consist of a round channel frame, single reinforced axel, and single removable circular blade fabricated from steel with enamel finish. Damper shall be continuous pivoting in externally mounted bronze sleeve bearings and axle seals on each side of the damper frame.

Damper shall be equipped with EPDM synthetic rubber blade seals for low leakage performance up to 250°F maximum. Leakage shall not exceed 0.029 cfm/perimeter inch at 10 inwg at 70°F. Frame gauges, blade gauges, and axle diameters shall be equal to or exceed the model which is the basis of design. Provide with 24-volt modulating electric actuator, which uses a 4-20 ma signal. Actuators shall be by Valvcon, Belimo, or approved equivalent. Basis of Design is Greenheck model HCDR-351.

**Acceptable Manufacturers**
- Greenheck
- Ruskin
- Air Balance
- Penn Ventilator
2.2.11. **Butterfly Backdraft Dampers**

Provide stainless steel heavy-duty backdraft damper with one (1) continuous rod in the center and neoprene seals at the edge of the damper to prevent air leakage.

**Acceptable Manufacturers**
- Cook
- Ruskin
- Air Balance

2.2.12. **Backdraft Dampers (rated at 4.0 to 10.0inwg)**

Dampers shall consist of: 6063T5 extruded aluminum channel frame with 2” depth; blades from 0.050” minimum 6063T5 extruded aluminum; synthetic polycarbonate axle bearings; damper shall be equipped with extruded vinyl blade seals; and internal aluminum linkage. Parallel counterbalanced blades, sized for indicated flow velocity, and factory-set to relieve at indicated static pressure. Provide suitable damper based on direction of airflow. Basis of Design is Greenheck EM series.

**Acceptable Manufacturers**
- Greenheck
- Ruskin
- Air Balance
- Arrow United Industries
- Penn Ventilator

2.3. **FIRE AND SMOKE DAMPERS**

Damper material of construction shall match the material of the ductwork in which it is installed, unless otherwise indicated.

2.3.1. **One Hour and Two Hour Fire Dampers**

Provide one and a half hour rating UL555 classified fire dampers where shown in ductwork penetrating one and two hour construction. Minimum 20-gauge out of air stream frame with minimum 24-gauge blade assembly. Closure springs shall be 301 stainless steel constant force type with positive lock in closed position and 165°F fusible link, unless otherwise indicated. Basis of Design is Greenheck model DFD-150.

**Acceptable Manufacturers**
- Greenheck
- Ruskin
- Air Balance

2.3.2. **Three-Hour Fire Dampers**

Provide three-hour rating UL555 classified fire dampers where shown in ductwork penetrating three hour construction. Minimum 20-gauge out of air stream frame with minimum 24-gauge blade assembly. Closure springs shall be 301 stainless steel constant force type with positive lock in closed position and 165°F fusible link, unless otherwise indicated.

**Acceptable Manufacturers**
- Greenheck, Series DFD-300’s
- Ruskin, DIBD23
- Air Balance
2.3.3. Fire/Smoke Dampers

Provide UL555/UL555S classified combination fire/smoke dampers as indicated on drawings. Dampers shall be leakage rated Class II on both sides of the damper, and temperature rated 350°F. 16-gauge multi-blade assembly with silicone rubber edge seals, 16-gauge frame with low profile head and sill on sizes under 17” in height to maximize free area and performance, and stainless steel compression type jamb seals. Fire rating of dampers shall match rating of assembly penetrated, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated. Provide 160 to 165°F fusible link, unless otherwise indicated.

Acceptable Manufacturers
   Greenheck, Series FSD
   Ruskin, Model FSD36
   Air Balance

2.3.4. Fire/Smoke Damper and Smoke Detector Assemblies (FSD)

Provide UL555/UL555S combination fire/smoke damper and smoke detector assemblies for horizontal mounting as indicated on drawings. The leakage rating under UL555S shall be Leakage Class II, OR III, and the damper and actuator shall be qualified under UL555S to an elevated temperature rated 250°F. The blades shall be opposed action, 14-gauge, single piece, air-foil shape with silicone rubber and galvanized steel edge seals. Frame shall be minimum 16-gauge galvanized steel formed into a structural hat channel reinforced at corners for added strength with stainless steel compression type jamb seals.

Acceptable Manufacturers
   Greenheck
   Ruskin Mfg. Co: Model FSD60 - DSD w/ SP-100, or approved equivalent.

2.4. TURNING VANES

2.4.1. Turning Vanes

Factory manufactured turning vanes constructed of material to match ductwork, 1-1/2” wide, 24-gauge minimum, curved airfoil double wall blades, supported with bars perpendicular to blades, and set into side strips suitable for screw or pop rivet mounting on opposite sides of duct. Seal over screws or rivets with sealant to make airtight.

2.4.2. Acoustic Turning Vanes
2.5. **DUCT ACCESS DOORS**

Provide for access to all automatic dampers, temperature sensing or control devices, fire dampers, damper motors, plenums, air filters, and all other items within the ductwork or housing which require inspection, service or adjustment, or where indicated.

Access doors in round ductwork shall be 12" x 16" minimum for ductwork 14" diameter and larger; and shall be 8" x 12" for ductwork 12" diameter or less. Rectangular ductwork and plenum doors shall be 12" x 16" minimum and shall be 8" x 12" for ductwork with 12" dimension or less.

Access doors less than 12” square shall have no hinges and two cam locks. Access doors up to 18” shall have continuous hinge and two cam locks. Access doors 18” and larger shall have no hinges and two cam locks per side.

Fabricate doors in conformance with SMACNA details and shall be pressure rated for the installed duct system and be airtight. All gaskets shall be neoprene.

Provide flush frames for un-insulated ductwork and extended frames for externally insulated duct. Provide vision panels where indicated on drawings.

**Acceptable Manufacturers**

- Ruskin
- Air Balance
- Duro Dyne
- Karp

2.6. **FLEXIBLE CONNECTIONS**

Provide flexible duct connections wherever ductwork connects to vibration isolated equipment, or where shown. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make duct connection with flanges and neoprene gaskets for airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

**Acceptable Manufacturers**

- Duro Dyne, Metalfab Canvas
- Flow-Flex, Fabric Connections
- Ventfabrics, Ventfab Metailedge

2.7. **AIR FLOW MEASURING STATION**

**General:** Provide air flow measuring stations as indicated and scheduled on drawings. Provide traversing automatic averaging type consisting of 14 ga. galvanized steel, aluminum honeycomb equalizer, and copper static and total pressure sensing manifold.

**Acceptable Manufacturers**

- Ebtron
- Approved Equivalent
PART 3.- EXECUTION

3.1. INSTALLATION OF DUCTWORK ACCESSORIES

Bearing Seals: Provide damper end bearings on the ends of all damper rods where they penetrate the duct, to seal and prevent air leakage.

Remote Damper Operators: Provide Young Regulator damper adjustment device for dampers located above all inaccessible ceilings. Seal airtight around recessed operator to prevent air leakage.

Controls: Install all control devices, sensors, etc. in ductwork or AHU systems where shown on drawings.

Install ductwork accessories in accordance with manufacturer’s installation instructions, with applicable portions of construction details as shown in SMACNA standards, and with recognized industry practices to ensure that products serve intended function.

Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

Install access doors for access to all automatic dampers, temperature sensing or control devices, fire dampers, damper motors, plenums, air filters, humidifiers, and all other items within the ductwork or housing which require inspection, service or adjustment.

Where items are installed in ductwork and located behind a removable air grille or register, an access door is not required in the ductwork.

Label access doors to indicate purpose.

Label exposed side of lay-in ceilings where access doors occur.

Fire and combination fire/smoke dampers shall be installed using a minimum 20-gauge galvanized steel sleeve, and galvanized steel angle frame (not less than 10-gauge) on each side of opening, attached to damper sleeve. Installation of dampers shall be in accordance with NFPA requirements, and manufacturer instructions, describing the UL approved installation procedure. Seal off space between sleeve and the building construction tightly with fire stopping.

Install turning vanes in all square or rectangular bends, elbows, and tees in supply, return, and exhaust air systems. Ensure that turning vanes are installed at the correct angle for the air turn.

3.2. FIELD QUALITY CONTROL

Operate installed ductwork accessories to demonstrate compliance with airtight construction. Test for air leakage while system is operating to obtain a total system leakage of one percent total design airflow. Repair or replace faulty accessories, to obtain proper operation and leak proof performance.

3.2.1. ADJUSTING AND CLEANING

Adjusting: Adjust ductwork accessories for proper settings, and adjust for proper action.

Extra Stock

Furnish extra fusible links to Owner, one (1) link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION

Project No. 162848.00

230910 - 8 of 8

Ductwork Accessories

Rev. A, 03/16/17

Issue for Bid
SECTION 230932  AIR OUTLETS AND INLETS

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PART 1. - GENERAL

1.1 QUALITY ASSURANCE

CODES AND STANDARDS

NFPA Compliance: If air outlet is pre-insulated, then insulation shall comply with the latest version of NFPA 90A “Air Conditioning and Ventilating Systems.”

AHRI Compliance: Units shall be tested, rated, and certified in accordance with the latest version of AHRI Standard 880.

1.2 RELATED DOCUMENTS

In addition to the drawings and general conditions specification for the project, applicable sections of the following documents apply to and comprise part of the document:

- 230010 “Basic Mechanical Requirements”
- 230050 “Basic Mechanical Materials and Methods”

1.3 SUBMITTALS

Product Data: For each type of product indicated, include the following:

- Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
- Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

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.
It is the responsibility of any manufacturer providing submittals to verify in advance their performance criteria shall match the basis of design manufacturer in the following criteria.

- **General compatibility** - style, construction, ceiling or wall integration, fastening, color, accessories.

- **Performance:**
  - NC level shall be equal to or less than BOD
  - Static and total pressure shall be equal to or less than BOD
  - Isothermal throw data at 150/100/50 fpm shall be within 5% plus or minus the BOD values for standard products. Air devices for labs and critical spaces shall be shown with cooling temperature differentials of 5/10/15 degrees and throws of 100/75/50/30 fpm.
  - Data shall be presented by computerized selection software. Catalog charts and graphs are not acceptable unless the tabular data is rated within 5% of the actual performance points scheduled on the drawings.
  - Manufacturers not complying with all portions of all requirements will be rejected and not subject to further review by the design professional.

**PART 2. - PRODUCTS**

2.1. **CEILING AIR DIFFUSERS, REGISTERS, AND GRILLES**

**General:** Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers, registers, and grilles as shown; of size, shape, capacity, finishes, type, and with accessories indicated on attached datasheet and/or as scheduled; constructed of materials and components as indicated, and as required for complete installation.

**Performance:** Provide ceiling air diffusers, registers, and grilles that have, as minimum, temperature and velocity traverses, throw and drop, pressure loss, and noise criteria ratings for each size device as listed in manufacturer's current data.

**Surface Compatibility:** Provide with border styles and mounting hardware that are compatible with adjacent construction materials, and that are specifically manufactured to fit into type of construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction that will contain each type of ceiling air diffuser, registers, and grilles.

**PART 3. - EXECUTION**

3.1. **EXAMINATION**

Examine areas where outlets and inlets are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. **INSTALLATION**

**General:** Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories.

Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop.

Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

Seal around all air inlet diffusers, grilles, and outlet grilles with silicone sealant to make airtight joint between substrate and air outlet or inlet. Not required for diffusers located in lay-in ceilings.

Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3. ADJUSTING

After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4. SPARE PARTS

Furnish to Owner, with receipt, three operating keys for each type of air outlet and inlet that require them.
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PART 1. - GENERAL

1.1. QUALITY ASSURANCE

Codes and Standards

NFPA Compliance: Construct air terminals using acoustical and thermal insulation complying with the latest version of NFPA 90A “Air Conditioning and Ventilating Systems.”

ARI Compliance: Units shall be tested, rated, and certified in accordance with the latest version of ARI Standard 880.

UL Compliance: Units with electric components shall be listed by either U.L. or E.T.L. with respect to the latest version of U.L. Standard 883.

PART 2. - PRODUCTS

2.1. SUPPLY AIR TERMINALS

General: Provide factory-fabricated and tested supply air terminals as indicated, selected with performance characteristics that match or exceed those indicated on Drawings.

Casings: Construct of 22-ga. zinc coated sheet metal.

Provide hanger brackets for attachments of supports.

Fiber free foam with solid metal liner

Normal Leakage: Construct casings such that when subjected to 0.5" w.g. pressure for low-pressure units, and 3" w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open.

Construct air dampers such that when subjected to 6" w.g. inlet pressure with damper closed, total leakage does not exceed 10% of specified air flow capacity.
Low Leakage: Construct casings such that when subjected to 0.5” w.g. pressure for low-pressure units, and 3” w.g. pressure for high-pressure units, total leakage does not exceed 1% of specified air flow capacity with outlets sealed and inlets wide open.

Construct air dampers such that when subjected to 6” w.g. inlet pressure with damper closed, total leakage does not exceed 5% of specified air flow capacity.

Damper or Air Valve: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide actuator to smoothly vary air volume through damper for minimum to maximum, in response from signal from controls.

Provide electronic controller and actuator, shall be 4-20 mA signal, 24 volt power and compatible with temperature controls.

Controls: Provide adjustable controls.

Provide pressure independent volume controller that is calibrated in cfm, factory-adjusted, and marked for minimum and maximum air capacities as shown on the drawings. Inlet of unit shall be provided with airflow sensor with a minimum of 12 sensing points. The controller shall limit the minimum and maximum cfm regardless of changes in the air system duct static pressure at inlet of box.

Identification: Provide label on each unit indicating unit number, cfm range, cfm factory setting, and calibration curve (if required).

2.1.1. Variable Air Volume (VAV) or Constant Air Volume (CAV) Terminals

Provide the capacities, features, and accessories indicated on drawings and schedule:

Hot Water Heating Coils: Provide heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.

Acceptable Manufacturers: Subject to compliance with requirements, provide air terminals of one of the following:

Price Industries
Titus
Krueger

PART 3. - EXECUTION

3.1. INSTALLATION OF AIR TERMINALS

General: Install air terminals as indicated, and in accordance with manufacturer’s installation instructions.

Install all units with a minimum of 2’-6” of straight inlet duct. Flexible duct upstream of the terminal unit shall not be permitted.

Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
3.2. **FIELD QUALITY CONTROL**

Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.3. **CLEANING**

Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

END OF SECTION
SECTION 230970

CONTROL SYSTEMS

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PART 1. - GENERAL

1.1. DESCRIPTION OF WORK

Provide all labor, materials, equipment, and services necessary to design, procure, install, start up and test a complete and operating Building Automation System (BAS), utilizing Direct Digital Controls (DDC) for energy management, sensing/measurement instrumentation, actuation devices, equipment monitoring and control, and subsystems with open communications capabilities and host computer/graphical user interface as indicated on the drawings and as specified herein. System shall be capable of utilizing standard protocols as well as being capable of integrating third-party systems via existing vendor protocols. System shall be capable of BACnet communication according to ASHRAE standards and shall be capable of OPC server communications. The BAS shall be validated in accordance with 21 CFR Part 11.
The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The equipment manufacturer shall certify, in writing, that their company prepared the shop drawings and that all control equipment was installed under their direct supervision.

All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two (2) years.

BAS manufacturer shall be responsible for all Control wiring for a complete and operable system. All wiring shall be in accordance with all local and national codes.

CRB Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans that are required to meet the functional intent and sequence of control shall be provided.

1.2. DIVISION OF WORK

The BAS Contractor shall provide damper and valve actuators, temperature instruments, humidity instruments, pressure instruments, flow instruments, level instruments, resistivity instruments, relays, transformers, and miscellaneous equipment and hardware to provide the specified control functions as outlined in the attached sequence of control.

The BAS Contractor shall furnish all control valves, regulators and automatic dampers indicated on P&ID drawings unless specifically designated (FWE) Furnished with Equipment. Installation will be by the Mechanical Contractor.

The BAS Contractor shall furnish and install all actuators including necessary linkages, wiring and tubing for dampers furnished with air handling units unless specifically designated (FWE) Furnished with Equipment on the P&ID’s.

The BAS Contractor shall furnish all thermowells, pressure gauges, and temperature gauges for installation by the Mechanical Contractor.

The BAS Contractor shall provide all necessary control wiring, conduit, and piping required to provide the specified control sequences. The Electrical Contractor will only provide and terminate power wiring to include, but not necessarily be limited to, BAS control panels located throughout the building, wiring of all power feeds through all disconnects and starters to electrical motors and manual or automatic motor speed control devices not furnished by BAS manufacturer.

The BAS Contractor shall furnish CAV and VAV controllers to terminal unit manufacturer for mounting and integration on each terminal, so that the terminal unit manufacturer may fully terminate and integrate the controller to actuators and airflow sensors. This work shall be coordinated through the Mechanical Contractor.

The BAS Contractor shall provide control cable, wiring and terminations between loose components, auxiliary panels and main panels of the equipment specified in Division 23 as required in the individual equipment specifications, indicated on the P&ID’S and described in the sequence of Control. Connection information shall be per equipment manufacturer’s drawings.
1.3. **CHANGES TO SCOPE**

Following award of contract, any changes to the scope of work shall be put in writing, and will require approval of the Owner or the Owner's representative prior to proceeding. All change order proposals must include detailed pricing of material and labor.

1.4. **RELATED DOCUMENTS**

Division 23 – 230010 Basic Mechanical Requirements and 230050 Basic Mechanical Materials and Methods apply to work of this section. Other sections that apply to this section include but are not limited to:

- 016800 – Tagging and Identification

Division 26 - Electrical specifications apply to conduit and wiring work of this section.

1.5. **CONTRACTOR QUALIFICATIONS/QUALITY ASSURANCE**

All work described in this section shall be installed, wired, circuit tested and calibrated by factory trained electricians and mechanics qualified for this work and in the regular employment of the BAS Contractor.

The BAS system shall be designed and installed, commissioned and serviced by trained engineers, technicians, electricians and mechanics, qualified for this type of work. Manufacturer shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

All BAS peer-to-peer network controllers, central system controllers, and local user displays shall be UL Listed and be so listed at the time of Bid.

Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.

1.6. **CODES AND STANDARDS**

Provide electrical components of control systems that are UL listed and labeled.

Comply with NEMA standards pertaining to components and devices for control systems.

Comply with NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems” and NFPA 79 “Electrical Standard for Industrial Machinery” where applicable to controls and control sequences.

Comply with National Electric Code.

Comply with UL-916 - Energy Management Equipment.

Comply with ASHRAE/ANSI 135 (BACnet)
1.7. SUBMITTALS - WITH BID

Sample Graphic Screens: Submit sample graphic screens in color that are typical of what will be provided for this type of project.

System Architecture Drawing: Submit drawing indicating overall network of DDC Controllers, Application Specific Controllers, PC’s, Printers and all major system components indicating how they are networked, how many Controllers are being provided and what they Control.

1.8. SUBMITTALS - AFTER AWARD OF CONTRACT

Product Data: Submit one electronic copy of manufacturer’s technical product data for each control device furnished, indicating dimensions, capacities, performance, accuracy, electrical characteristics, and material finishes. Include installation, calibration, and start-up instructions.

Provide complete Control valve schedule indicating valve type, model number, size, Cv and maximum shutoff pressure for each Control valve on the project.

Shop Drawings: Submit six (6) copies of shop drawings for control system containing the following information. Any product or work indicated on drawings that is not provided by the Controls Contractor shall be clearly identified.

- Schematic flow diagram of system indicating fans, pumps, coils, dampers, valves, and control devices as applicable to project.
- Point names and addresses for each control device labeled with setting or adjustable range of control.
- All required wiring including terminal identification. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Provide cable schedule with complete termination details for field-installed wiring.
- Details of control panels, including panel layout, controls, instruments, labeling, and bill of materials.

Instrument location plans showing the location of all panels and field devices.

Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device.

Record Drawings: Upon completion of the work, provide a complete set of record drawings indicating the BAS system as installed. Drawings shall be provided as AutoCAD (latest version) files in hard copy and on CD-ROM.

Calibration Sheets: Provide field or factory calibration sheet for each instrument and control device that can be calibrated.

System Manuals: Provide two (2) full hard bound sets of system Operating and Maintenance manuals which shall contain, as a minimum, the following:

1. Index sheet, listing contents in alphabetical order.
2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams.
3. System Schematic diagrams with written description of sequence of operations.
4. As-Built interconnection wiring diagrams.
6. System Network Architecture Drawing showing remote electronic panel locations, and all trunk data.
7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc).

1.8.1. WARRANTY

The BAS Contractor shall provide a one-year warranty and preventative maintenance agreement for the system, as part of the original bid. Any manufacturing defects arising during the warranty period shall be corrected without additional cost to the Owner. The preventative maintenance agreement shall include a minimum of quarterly service visits, include defective parts replacement and commence upon completion of the BAS system installation and acceptance by the Owner.

During the warranty period, the BAS Contractor shall respond to any problem related to the functional operation of the BAS. If BAS has been turned over to the Owner and a site presence has been removed from the project, then an on-line support service shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. The owner shall enable the BAS Contractor to have 24/7 remote access to the system, with prior approval, via secure modem or internet connection. This remote connection to the facility shall allow response to any problems within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays. If the local office cannot resolve the problem on-line, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 24 hours of the time that the problem is reported. Cost of the preventative maintenance agreement shall be listed as a separate item in the bid response.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide BAS system of one of the following vendors:

Siemens Building Technologies

2.2. SYSTEM DESCRIPTION

The BAS System shall consist of Standalone DDC Controllers, HVAC/Mechanical equipment Controllers, and Application Specific Controllers accessed via network PC workstations and portable operator terminals. Each Controller shall be completely standalone and will continue to function regardless of the status of any other Controller or device on the system.

The BAS Contractor shall provide a complete distributed DDC control system. A Controller shall control each unit operation, such as an air-handling unit. Controllers shall be linked on a network through a Network Control Module. Application specific controllers shall control CAV/VA and other terminal units. The system shall be a complete working system.
The BAS Contractor shall provide all automatic control devices, including sensors, relays, transducers, and related appurtenances. The system shall accomplish the control sequences required by the attached sequence of operation and the points listing. Control loops shall be implemented using direct digital control (DDC) methods that provide proportional-integral-derivative (PID) control algorithms. PID control loops shall be updated at least three (3) times per second. All pneumatic control piping and all control wiring required to allow the BAS to accomplish the sequence of operation shall be included.

Provide a true global system with Host Computer/Graphical User Interface (GUI) for Owner interface to the BAS system. The Host/GUI shall be complete with all required hardware and software as specified herein. The operating system shall be true multi-tasking and shall be based on standard off-the-shelf Microsoft Products such as XP, Windows 7 or Linux. (Obsolete or custom systems are unacceptable.)

2.3. NETWORKING COMMUNICATIONS

The design of the BAS shall network operator PC workstations and stand-alone DDC Controllers. The network architecture shall consist of three (3) levels, a site-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.

The design of the BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

System shall have the capability to communicate with a BACnet network over Ethernet or/IP.

System shall have the capability to be an OPC Server for dynamic communication with OPC Clients over an Ethernet network.

2.4. DDC CONTROLLER FLOOR LEVEL NETWORK:

This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers (Network Controllers/Network Control Engines) for transmission of global data.

2.5. DDC AND HVAC MECHANICAL EQUIPMENT CONTROLLERS

DDC and HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.

DDC and HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC and HVAC Mechanical Equipment Controllers, which require different programming language or tools on a network, are not acceptable.

2.5.1. DDC Controller – Network Controllers/Network Control Engines

DDC Controllers shall be 32-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks. Network Controllers shall provide an Industrial Level Reliability via Industrial Grade Single Board Computer (SBC), Windows XP Embedded Operating Systems, Non-Volatile Solid State Flash Card Memory and battery back up to transfer Volatile DRAM Memory to Flash Card Memory on power failure.
Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring
10. HTML/XML Graphics

Each Controller shall be capable of supporting the following types of I/O: 4-20mA, 0-10Vdc, 1000 ohm or 10K ohm thermistors, RTD’s, Dry contact closures, Pulse accumulation, voltage sensing, 0-20 psi pneumatic. Provide 20% spare I/O or two (2) points of each type I/O in use on each controller, whichever is greater.

Each DDC Controller shall support firmware upgrades without the need to replace hardware.

Provide all processors, power supplies, and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

DDC Controllers shall provide a minimum two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator’s terminals.

DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals. DDC Controllers shall also provide a minimum of one (1) Ethernet (10/100MB) Port, two (2) RS-485 Ports, two (2) USB Serial Ports and one (1) LonWorks Compatible Port.

Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components.

The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

- RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3 V
- Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

Isolation shall be provided at all peer-to-peer panels’ AC input terminals to suppress induced voltage transients consistent with:

- IEEE Standard 587-1980
- UL 864 Supply Line Transients

In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software.
Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days. Upon power failure at the network controller/network engine level all volatile memory shall be moved to Flash Card Memory.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation in an orderly fashion without manual intervention.
2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

Provide a separate DDC Controller for each AHU or other HVAC system. It is intended that each unique system be provided with its own point resident DDC Controller.

2.5.2. HVAC/Mechanical Equipment Controllers

HVAC Mechanical Equipment Controllers shall be a minimum 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.

Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Dial-up communications

Each Controller shall be capable of supporting the following types of I/O: 4-20mA, 0-10Vdc, 1000 ohm or 10K ohm thermistors, RTD’s, Dry contact closures, Pulse accumulation, voltage sensing, 0-20 psi pneumatic.

Provide 20% spare I/O or two (2) points of each type I/O in use on each controller, whichever is greater. Refer to the attached points list.

Each HVAC/Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.

HVAC/Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.

HVAC/Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

Each HVAC/Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components.

The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

- RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3 V
- Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- Output Circuit Transients per UL 864 (2400V, 10A, 1.2 Joule max)

Isolation shall be provided at all peer-to-peer panels’ AC input terminals to suppress induced voltage transients consistent with:

- IEEE Standard 587
- UL 864 Supply Line Transients

In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

Upon restoration of normal power, the HVAC/Mechanical Equipment Controller shall automatically resume full operation in an orderly fashion without manual intervention. Should HVAC/Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.6. FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASC)

Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASC’s) through Floor Level LAN Device Networks.

Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.

Terminal Equipment Controllers

Provide for control of each piece of equipment, including, but not limited to, the following:

1. Constant/Variable Air Volume (CAV/VAV) boxes
2. Reheat Coils.
3. Room Pressurization

Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 4-20mA, 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.

All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.

All analog I/O shall have A/D resolution appropriate for the required control tolerances as stated in Section 3. The hardware shall be suitable for the anticipated ambient and electrical classification conditions. Controller used in conditioned ambient shall be mounted in dust-proof enclosures and shall be rated for operation at 48° F to 112° F (9° C to 45° C).
Controllers shall provide LEDs for power and communications. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

The ASC shall maintain all BIOS and programming information in the event of a power loss for at least 90 days. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. The power supply for the ASC shall be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

The BAS contractor shall furnish terminal equipment controller, damper motor and flow transducer for installation by the terminal unit manufacturer under Division 23 contractor. The cost of the factory mounting, wiring and enclosure shall be included by the air terminal unit manufacturer.

2.7. LOCAL USER DISPLAY

Where specified in the sequence of operation or points list, the controllers on the peer-to-peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.

1. The display shall use the same security password and access rights for points in the display as is used in the associated controller.
2. The LCD display shall be a minimum of a two-line 40-character display.
3. The LCD display shall include the full point name, value (numeric, digital or state text), point priority and alarm status on one (1) screen.
4. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.
5. The display shall be mounted either on the door of the enclosure or remote from the controller.

2.8. SENSORS AND DEVICES

Provide sensors and devices as specified below. Refer to P&ID’s, BAS Drawings and Mechanical Schedules for set points and sizing requirements.

The sensor and device manufacturers listed in the specifications that follow have been pre-qualified. The BAS Contractor may submit alternate products for approval if desired. Alternatives must be equal or superior to specified products in all respects.

Differential Pressure Switches/Gauges

Differential pressure gauges for filter service shall be minimum 3-1/2", round with glass face and bottom or back connections. Face of gauge shall have white background with black characters. Provide switch type gauge where indicated on P&ID’s or other drawings.

Manufacturers

Dwyer (Magnehelic or Photohelic)

Temperature Sensors/Transmitters

Temperature sensors shall be thermistors (10K ohm at 77°F) or RTD’s (PT100 or PT1000 curve; 100ohm or 1000 ohm). Sensors in the return or discharge duct shall be of the single point type. Sensors in the air-handling unit shall be of the averaging type.

Room temperature sensors shall be available in a minimum of two (2) configurations:

Sensing element only (Manufacturing and GMP areas)
Sensing element, LCD display and keypad (Office/Lab areas)
Thermowells shall be brass or stainless steel for non-corrosive fluids below 250°F and 304 series stainless steel for all other applications.

Thermowells shall be 316 SS and have sanitary Tri-Clamp fitting to the process for sanitary service.

Depth of thermowells shall be coordinated with Mechanical Contractor to ensure tip of well is at the approximate midpoint of the process for line measurement and for additional installation requirements.

Minimum Accuracy shall be +/- 0.3 % of the total sensor range. Sensor ranges for applications shall include the following:

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space sensor</td>
<td>0-100°F</td>
</tr>
<tr>
<td>Duct sensor</td>
<td>0-100°F</td>
</tr>
<tr>
<td>Outside Air sensor</td>
<td>-20-150°F</td>
</tr>
<tr>
<td>Air handling unit averaging sensor</td>
<td>0-100°F</td>
</tr>
<tr>
<td>Immersion sensors</td>
<td>0-250°F</td>
</tr>
</tbody>
</table>

Provide manufacturers’ required transmitters meeting the accuracies noted above.

If the manufacturers’ standard system can read RTD’s and Thermistors via direct connect application then transmitters are not required.

Manufacturers

- RdF
- Minco
- Rosemount
- PreCon
- Automation Components Inc.

Room/Duct Pressure Transmitters

Room/Duct pressure transmitters shall be capable of measuring low static or differential pressures using a variable capacitance technique. Accuracy shall be +/- 1% of full scale or better. Sensor ranges shall be as follows:

<table>
<thead>
<tr>
<th>Transmitter Type</th>
<th>Pressure Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct Static pressure transmitters</td>
<td>0 to 10” w.c.</td>
</tr>
<tr>
<td>Room Differential pressure transmitters</td>
<td>0 to +/-0.1” w.c. or 0 to +/- 0.25” w.c.</td>
</tr>
</tbody>
</table>

Manufacturers

- Setra
- Modus
- Air Monitor
- Automation Components Inc.
- Ashcroft

Line Pressure Transmitters

Line pressure transmitters shall be capable of measuring pressures using a variable capacitance technique. Accuracy shall be +/- 1% of full scale. Coordinate with the Mechanical Contractor for installation requirements.
Manufacturers

- Rosemount
- Endress and Hauser
- Foxboro
- Robinson-Halpern

Duct Airflow Transmitters

Duct airflow transmitters shall be capable of measuring flow by sensing total and static pressure. The measured velocity pressure converted to airflow shall have an accuracy of +/- 2% of full scale. Sensors shall cover the full dimensions of the associated duct being measured. Coordinate with the Mechanical Contractor for installation requirements.

Manufacturers

- Ebtron

Fan Inlet Airflow Measuring Station

Each station shall contain parallel air straightener, total, and static pressure sensing manifolds, internal piping and external pressure transmission ports with flexible tubing and quick-connect fittings. Fabricate of galvanized steel, size for fan inlet in which mounted. Maximum pressure loss through station of 0.08 inches water gage at 1500 fpm. Station shall have accuracy of +/- 2%. Identify by model number, size, area, and specified airflow capacity.

Manufacturers

- Air Monitor
- Brandt

Line Flow Transmitters

Line flow transmitters shall be capable of measuring flow to an accuracy of +/- 2% of full scale. Coordinate with the Mechanical Contractor for installation requirements.

Manufacturers

- Rosemount Annubar
- Yokogawa
- Endress and Hauser
- Foxboro

Humidity Transmitters

Humidity transmitters shall be capable of measuring relative humidity to an accuracy of +/- 2% RH scale. All sensors shall be field calibratable with a portable service kit.

Manufacturers

- Vaisala
- Automation Components Inc.
- AirTest Technologies
Temperature Switches

Temperature switches shall be snap-acting switches that have manual reset for freezestat applications and automatic reset for other applications.

Manufacturers

- Penn
- SOR
- Ashcroft
- United Electric

Pressure Switches

Pressure switches shall be snap-acting switches that operate using a diaphragm technique.

Manufacturers

- Dwyer
- Penn
- SOR
- Ashcroft
- United Electric

Control Valves

Control valves 2” and smaller shall be ball type with equal percentage characteristics and threaded end connections. Control valves 2-1/2" and larger shall be either ball type or high performance butterfly type with flanged end connections, also with equal percentage flow characteristics. Valves shall be two-way or three-way as indicated on the PID’S. Valves shall be provided with an electronic actuator (per the P&ID’s) and a positioner. The valve body material and trim shall be as required in Specification Section 230500 – Piping Materials, with stainless steel stem. Coordinate with the Mechanical Contractor for installation requirements.

All automatic temperature control valves in water lines shall be provided with characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or equal to the pressure drop of the coil being fed, whichever is less.

Steam Control valves shall be sized so that the total pressure drop at design flow is equal to or greater than 40% of the absolute upstream pressure. Should this result in an unacceptably low downstream pressure in the case of low-pressure steam systems then the valve should be sized for a minimum five (5) psi pressure drop.

- Chilled water valves shall be rated for minimum 125 psig and have standard trim for the application. The chilled water valves shall fail to the last position. The control valve shall be suitable for chilled water to a minimum of 35°F (2°C).
- Heating valves shall fail open and be provided with spring return actuators. The control valve for hot water shall be suitable to a maximum temperature of 250°F (120°C).
- Two-Inch and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends (with back seating capacity repackable under pressure).
- Over Two-Inch: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc. Rate for service pressure of 150 psi at 250°F.

Two-position valves shall be line size and include a pneumatic actuator and electric solenoid.
Control valves shall be ANSI rated to withstand the pressures and temperatures encountered. The control valve shall have metal-to-metal seats, stainless steel stems and O-ring packing. Control valves shall be selected to provide tight shut off (ANSI Leakage Class IV) against maximum system pressure differentials.

Maximum System differential pressures are as follows:

Manufacturers

Siemens  
Johnson  
Baumann  
Fisher  
Honeywell

Electronic Control Valve Actuators

Electronic Terminal Unit Valve Actuators shall be powered with 24Vac from the local BAS control panel.

The valve actuator shall be identified as a Class 2 operating device, according to NEC, Article 725 and shall be tested and listed by Underwriters Laboratories according to UL873, and shall bear the UL and cUL approval symbols. The valve actuator shall be designed and tested to NEMA 1 standards, according to NEMA 250.

The control valve actuator shall be equipped with a manual override feature, allowing operation of the control valve upon loss of control power or signal, without the aid of a separate tool or auxiliary power supply. The valve actuator shall provide indication of valve stem position.

The valve shall be Siemens Flowrite EA 599 Series, SKB/C Electronic Valve Actuator or approved equal.

Solenoid Valves

Solenoid shall have three-port operation: common, normally open, and normally closed. They shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications. Coils shall be equipped with transient suppression devices to limit transients to 150% of the rated coil voltage.

Manufacturers

Asco  
Johnson Controls

Electronic Damper Actuators

Electronic Damper Actuators shall be powered with 24Vac from the local BAS control panel.

The damper actuator shall be identified as a Class 2 operating device, according to NEC, Article 725 and shall be tested and listed by Underwriters Laboratories according to UL873, and shall bear the UL and cUL approval symbols. The actuator shall be designed and tested to NEMA 1 standards, according to NEMA 250.

The actuator shall be equipped with a manual override feature, allowing operation of the damper upon loss of control power or signal, without the aid of a separate tool or auxiliary power supply. The actuator shall provide indication of damper position.
Manufacturers

Siemens
Johnson

Room Static Pressure Elements

Room pressure elements shall be wall or ceiling flush mount and constructed of stainless steel for clean areas. A 1/4" fitting shall be available for connection to the sensing tubing system.

Manufacturers

Air Monitor S.A.P./R (Recessed Flush) S.A.P./S (Surface)

Pressure Regulators

Pressure regulators shall be self-contained with threaded connections for pipe sizes 2” and smaller and flanged connections for pipe sizes 2-1/2” and larger. Regulators shall be sanitary rated with Tri-Clamp connections for sanitary service. Natural gas regulators shall be rated specifically for natural gas service. Coordinate with the Mechanical Contractor for installation requirements.

Manufacturers

Fisher
Cashco
Jordan

Level Instruments

Level instruments for sanitary USP service shall have Tri-Clamp connection to vessel and shall be magnetorestrictive type with 316 SS rod and float. Coordinate with the tank manufacturer and the Mechanical Contractor for installation requirements.

Manufacturers

MTS

Air Sets

Air sets shall be provided for each control air connection. Air sets shall include regulator, gauge and filter and be sized for the application. Multiple components may be grouped on a common air set for installations where multiple components are installed in close vicinity.

Manufacturers

Norgren
Fairchild
Johnson Controls A-4000 Series

Damper Position Switches

Damper position switches shall be snap acting type.
Manufacturers

Telemecanique

Alarm Lights

Unclassified Areas: Remote alarm lights shall be Square D model 9001KP standard pilot light. Verify dome color with owner. Bulbs shall be LEDs.

Manufacturers

Square D

Remote Switches

Unclassified Areas: Remote switches shall be two-position booted flush mounted push buttons. Switches shall contain 1 NO/1 NC contact. Verify switch color with owner.

Manufacturers

Allen Bradley
Square D

Current Sensing Relay

Provide solid-state, adjustable, current operated relay. Provide a relay, which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.

Adjust the relay switch point so that the relay responds to motor operation under load as an “on” state and so that the relay responds to an unloaded running motor as an “off” state. A motor with a broken belt is considered an unloaded motor.

Manufacturers

Load Controls
ABB

2.9. CONDUIT, WIRE AND TUBE

General

Install, connect, and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All wiring shall be installed in conduit.

Provide wiring between all sensors, transmitters, and other control devices all control and alarm wiring for all control and alarm devices for all Sections of Specifications.

Coordinate with Division 26 Contractor to ensure provision of 120 volt, single phase, 60 hertz emergency power to every BAS DDC Controller panel, HVAC/Mechanical Equipment Controller, PC console, power supply, transformer, annunciator, modems, printers and to other devices as required. It is the intent that the entire building automation system shall be operative under emergency power conditions in the building. The power supplies are to be extended in conduit and wire from emergency circuit breakers.
Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.

Provide conduit and control wiring for devices specified in this Section.

Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.

Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors and BAS panels, as shown on the drawings or as specified.

All wiring to be compliant with local building code and the NEC.

Provide electrical wall box and conduit sleeve for all wall-mounted devices.

**Conduit**

Conduit shall be as specified in Division 26 Electrical specifications.

**Wiring**

All wire shall be stranded copper and meet the minimum wire size and insulation class listed below. Wire used for analog circuits shall be twisted and shielded.

<table>
<thead>
<tr>
<th>Type</th>
<th>Wire Size</th>
<th>Insulation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>12 Gauge</td>
<td>600 Volt</td>
</tr>
<tr>
<td>120 V Control</td>
<td>14 Gauge</td>
<td>600 Volt</td>
</tr>
<tr>
<td>24 V Control</td>
<td>18 Gauge</td>
<td>300 Volt</td>
</tr>
<tr>
<td>Communications</td>
<td>Per Mfr.</td>
<td>Per Mfr.</td>
</tr>
</tbody>
</table>

**PART 3. - EXECUTION**

3.1. **INSTALLATION OF CONTROL SYSTEMS**

Install systems and materials in accordance with manufacturer’s instructions, shop drawings and details indicated on drawings.

Electrical components located in electrically classified hazardous locations shall meet the proper requirements for these locations by utilizing intrinsic safety (preferred method), purged enclosures or explosion-proof devices.

3.2. **FIELD QUALITY CONTROL**

All work, materials and equipment shall comply with the rules and regulations of applicable local, province, and federal codes and ordinances as identified in Part 1 of this Section.

Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.
3.3. **MOUNTING AND INSTALLATION PRACTICES**

- Well-mounted sensors and gauges shall include thermal conducting compound within the well to ensure good heat transfer to the sensor.

- Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100% of the stroke.

- Dry contact outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

- Water or steam line mounted sensors shall be removable without shutting down the system in which they are installed.

3.4. **WIRING AND TUBING PRACTICES**

- All control and interlock wiring shall be installed in conduit unless otherwise noted. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

- All wiring shall meet local and national codes. All BAS equipment power shall be the responsibility of the Division 26 Electrical Contractor. It is the responsibility of the BAS Contractor to coordinate with the Division 26 Electrical Contractor on the final locations to which BAS equipment power is wired.

- Conduit, in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction.

3.5. **SENSOR CALIBRATION**

- The Contractor shall provide three-point calibration factory records for all calibrated instruments. Where Factory Certifications and NIST Traceable Instrument Documentation are not available, contractor shall provide field/witnessed calibrations. After calibration, instruments shall be handled as little as possible.

- The Contractor shall perform signal transmission checks for all I/O points.

- All analog sensors shall receive single point verification with a certified instrument after installation.

- The single point verification shall be taken at midpoint of normal operating range.

- A three-point calibration shall comply with the specified accuracy. Contractor shall provide full continuity checks, receipt verification, installation verifications and operational verifications. Contractor shall submit all documentation as noted herein.

- The Contractor shall provide all factory and field Instrument Calibration Records performed and instrument Test Records filled out signed and submitted to the Construction Manager for distribution and permanent records.

3.6. **EQUIPMENT IDENTIFICATION**

- Refer to Specification 016800 for specific tagging and identification guidance.

- Identify each item, mounted on the face of a control panel. Identify each item of control equipment (except room sensors), with label.
Identify all control wires with self-laminating labels or sleeves using words, letters, or numbers that can be exactly cross-referenced with installation drawings.

Identify all pneumatic tubing with self-laminating labels or sleeves using words, letters, or numbers that can be exactly cross-referenced with installation drawings.

Junction box covers shall be marked to indicate that they are a part of the BAS system.

3.7. **ADJUSTING AND CLEANING**

**Start-Up:** Start-up, test, and calibrate control system. Provide a field or factory calibration sheet for each instrument and control device. Demonstrate compliance with requirements in presence of Owner’s authorized representative. Replace damaged or malfunctioning controls and equipment.

**Final Adjustment:** After completion of installation and calibration, adjust control components to operational values.

3.8. **CLEANUP**

At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings.

At the completion of work at the end of each day, remove from the building, premises, and surrounding streets, etc. all rubbish and debris resulting from the operations and leave all equipment spaces clean and ready for use.

3.9. **TEST INSTRUMENT AND CALIBRATION DOCUMENTATION**

**Test Instruments**

All calibration and test equipment used shall be traceable to the National Institute of Standards and Technology. Reference equipment used shall be a minimum of four (4) times more accurate than the instruments being calibrated. Exception: Two (2) times for humidity.

**Documentation**

The manufacturer shall provide current calibration certificates of all reference and test instruments used to perform field-testing prior to start of work.

All testing shall be documented by the manufacturer’s technician.

Provide contractors loop checkout report and calibration forms for Owner’s approval.

3.10. **TESTING AND INSPECTION CRITERIA**

All materials, hardware, software/firmware, and documentation to be furnished under this specification shall be subject to observation and tests. Equipment shall not be accepted until all required observations and tests have been made, demonstrating that the equipment conforms to the specification, and the hardware, software/firmware, and documentation, have been provided.
Approval of inspections and test results, acceptance of hardware, software/firmware, and documentation or the waiving of observations and tests thereof shall in no way relieve the Seller of the responsibility of providing equipment, software/firmware, and documentation which meets the requirements of this specification, nor shall such actions invalidate any claim which the Owner may make because of defective or unsatisfactory hardware or software/firmware.

The Owner reserves the right to request additional tests at no extra charge on any work that the Owner determines not to be in accordance with this specification.

Whenever the results of any observations or tests performed in accordance with the requirements of this section indicate that specific hardware, software/firmware, or documentation does not meet the specification requirements; the Seller shall replace, modify, or add, at no cost to the Owner, hardware, software/firmware, or documentation as necessary to correct the noted deficiencies.

The Owner shall have access to observe quality assurance (QA) standards, procedures, and records, which are applicable to this project.

Observations shall not relieve the Seller of the responsibility for providing material and equipment conforming to the requirements of the specification, nor shall such observations invalidate any claim, which the Owner may make because of defective or unsatisfactory hardware, software/firmware, or documentation.

The Seller shall submit test plans, and test procedure specifications for all field tests. The test plans shall be sufficiently documented by the Seller to ensure that each test is comprehensive and representative of the function to be exercised. The test plan shall cover testing of all hardware and software/firmware.

The test plans and procedures shall be submitted to the Owner and Owner’s Representative for approval in accordance with these specifications.

The Seller shall use their standard procedures as a guide in preparing the test documentation for the hardware portion of the tests. It shall be the responsibility of the Seller to complement these specifications with specific test criteria in order to show proper operation as specified and in conformance with manufacturers published data.

For the required areas, the field test plans and documentation shall contain the following items as a minimum:

1. The test schedule.
2. The purpose of each test.
3. The functions to be tested.
4. The plans and procedures to be followed.
5. Specific references to project documentation for correlation with the procedures and for verification of the documentation.
6. The test setup, equipment, simulation hardware and software, and conditions for each part of the test.
7. All test inputs and outputs.
8. Test software/firmware descriptions and listings.
9. A copy of any certified test data approved by Owner for use in lieu of testing.
10. Record keeping assignments, procedures, and forms.
11. Procedures for notification of all changes made to the system.
12. Expected results.
13. The acceptance criteria.
14. A procedure for handling and correcting test incidents and variances, which are identified during testing.
The Seller shall maintain a completed record of the results of all tests. This record shall include a Test Log, Test Incident Reports, and a Test Summary Report. The record shall also include the following items:

1. Reference to the appropriate sections of the test definition documents.
2. Description of any special test conditions or special actions taken.
3. Test results (passed/failed).
4. A corrective maintenance log, which shall reference the test, reports on any test incidents or variances encountered, along with a description of how the incidents or variances were corrected.
5. Identification of the Seller’s test engineer and representative witnessing the test.
6. Date of the test.
7. Provision for comments by the Owner’s Representative.
8. A copy of the Seller’s QA records associated with the items being tested.

The Seller shall maintain all test records. The test records shall be available to the Owner at all times and shall be submitted to the Owner by the Seller upon the successful completion of the tests.

A variance report shall be prepared each time a deviation from specification requirements is detected. The report shall include a complete description of the variance, including:

1. Reference to this specification and/or the test procedure.
2. A description of the test conditions at the time the variance was detected.
3. Description of corrective action.

The Seller shall document the corrective actions taken to eliminate each variance by providing sufficient detail for the Owner to determine the necessity and extent of the retesting of the offending function, any interaction with previously tested functions, and any documentation that may require updating as a result of the corrective action.

3.11. SYSTEM TESTING

Testing

Testing shall consist of two (2) types: Seller testing and Owner acceptance testing.

Assemblies and subassemblies shall be factory tested in accordance with Seller standard quality assurance program. This testing shall be done prior to site acceptance tests.

Site Acceptance Test

After the system is delivered and installed in the Owner’s facility, the system shall go through site acceptance test (S.A.T.). The S.A.T. will be concurrent with the BAS Instrument Commissioning. All documentation associated with Seller testing and the Owner’s acceptance testing shall be supplied to the Owner for his inclusion in the Validation Documentation where applicable.

Field Tests: The field tests shall begin after the Seller’s personnel have installed, started, and checked out the performance of the BAS equipment at the field location. Before any field-testing is started, the Seller shall verify that all hardware has been updated with the latest engineering changes. If any updates have been omitted that are deemed necessary to meet the specification, the Seller shall immediately perform the necessary modifications at no cost to the Owner.
Site Acceptance Test (S.A.T.): Following installation of the BAS system, all hardware shall be aligned and adjusted, and all test readings recorded in accordance with the Seller’s recommended tests and maintenance procedures. The Seller shall include, in the associated test report, a list of all hardware or components replaced or changed between the completion of the factory tests and the start of field installation tests.

All hardware shall be demonstrated to be operational by running the off-line diagnostics. The Seller and Owner shall determine the exact contents of the field installation test jointly. The S.A.T. test shall be considered complete only after all variances generated during installation are resolved and tested.

Startup Test and Punch Out: Prior to on-line operation, conduct a complete demonstration and readout of the computer’s real-time responsibilities of surveillance and control.

Demonstration of controls may include simulation of analog inputs (via the system keyboard or by applying an analog signal to appropriate control panels input terminals) and observation of the action of system final control elements. Perform punch out of all input/output points. Conduct startup test and punch out in the presence of Owner and the Owner’s Representative.

After Owner approved calibration documents have been reviewed, the Seller shall demonstrate all control sequences function as specified and the performance of each control loop is within specific limits. Graphical trends shall be recorded and printed for each control loop as to verify the loop stability is within the specified performance limits. Each trend shall be for duration of not less than two (2) hours.

The Owner shall be notified no later than five (5) days prior to scheduled startup testing.

Operational Acceptance Test: After all previous testing has been successfully completed; operate the BAS, for 14 days. Provide the Owner with a bound log reporting all BAS failures that occur during the operating acceptance test. The log shall show the point name and number, time and date of failure, and time and date of return to service.

Additionally, during the 14-day acceptance test, any operational failures due to malfunction of the control panels, wiring, or Control room Equipment shall designate a restart to testing if desired by the Owner. Any failure between field-sensing equipment and the control panels (included FEP’s) shall be corrected, and the testing shall continue from the day of failure.

The Owner shall determine the duration of all retests. If the season of the year prevents complete testing of any individual component(s) of the BAS, then acceptance will be conditional upon the successful demonstration of the specific component(s) at the appropriate season.

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Required Control Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Area Temperature</td>
<td>+/- 2 °F</td>
</tr>
<tr>
<td>Production Area Humidity</td>
<td>+/- 10 °F/RH</td>
</tr>
<tr>
<td>Production Area Pressure</td>
<td>+/- 0.005” wc</td>
</tr>
<tr>
<td>Duct Air Flow</td>
<td>+/- 3%</td>
</tr>
<tr>
<td>Duct Pressure</td>
<td>+/- 0.1” wc</td>
</tr>
<tr>
<td>Coil Discharge Temperature</td>
<td>+/- 2 °F</td>
</tr>
</tbody>
</table>

Final Acceptance: The BAS will not be considered accepted by the Owner until all of the foregoing tests are successfully completed. Beneficial use of the system by the Owner will not be considered as acceptance.
Final Acceptance Criteria: The Owner will deem the BAS to be fully accepted when:

1. All structured, unstructured and availability tests have been successfully completed, and all incidents and variances have been resolved to the Owner satisfaction.
2. All instrument calibration is current and acceptable to the Owner/Owner’s Representative.
3. All documentation and training requirements have been completed and are satisfactory to the Owner.
4. All maintenance and related contracts and releases of the Seller have been fully executed and provided to the Owner.
5. All identified defects have been corrected to the Owner’s satisfaction.
6. Owner has received all required software licenses.
7. Operational check verification forms (each control loop and discrete I/O).
8. Operational check completion report (each system).
9. Graphic trend printout (each loop).

END OF SECTION
SECTION 230971     HVAC SEQUENCE OF CONTROL

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</tr>
</tbody>
</table>

PART 1. - GENERAL

1.1. GENERAL

This sequence of control is provided for use by the controls contractor to develop his design. This document is not a “Users Requirement Specification” nor a “Functional Requirements Specification” but may be used by the responsible party to develop such documents.

1.2. RELATED DOCUMENTS

Specification sections 230970, 230972 and 230990

Equipment specifications

1.3. SUBMITTALS

The following sequences shall be augmented as necessary by the Controls contractor and submitted either as part of the controls submittal or as a separate Functional Requirements Specification for approval by the Engineer and Owner prior to commencing any programming.

PART 2. - PRODUCTS – NOT APPLICABLE

PART 3. - SEQUENCE OF CONTROL

3.1. AHU-5000:

3.1.1. Starting and Stopping

Generally this unit operates 24 hours per day, seven (7) days per week.

Normal Start

The system would normally be started from the system operator interface.
Upon a command to start, a signal is transmitted to the air handling unit motor starter, and to the outside air damper.

The air handling unit shall not start unless the following permissives are satisfied:

- Outside air damper is open as indicated by damper end switch.
- Smoke detectors are in “normal” condition.
- Freezestat is in “normal” condition.

Once started, all control loops shall be enabled. Once started, the air handling unit fan speed controller shall be adjusted by the output from supply air flow controller.

General analog alarms such as temperature/humidity and room pressure alarms shall be disabled for the first five minutes of operation (adjustable) to prevent multiple nuisance alarms during start up.

Upon a command to start, a signal is transmitted to the exhaust fan motor starter, and to the exhaust fan isolation damper.

The exhaust fan shall not start unless the following permissives are satisfied:

- Isolation damper is open as indicated by damper end switch.

Normal Shutdown

Under a normal shutdown a stop signal shall be transmitted to the air handling unit and/or exhaust fan motor starter.

The AHU and/or exhaust fan shall shutdown, all control loops and alarms shall be disabled, and all final control elements shall return to their normal position.

Once the AHU and/or exhaust fan is shutdown the outside air damper and/or exhaust fan suction dampers shall close.

Safety Shutdown

In the event that the freezestat senses a low temperature condition or smoke detectors sense smoke, the air-handling unit and exhaust fan shall be shut down.

Once the air-handling unit is shut down, the control system shall assume a commanded stop condition and shall not restart without a normal start command from the operator interface.

Fan Failure Shutdown

Should the air handling unit shut down for any unplanned reason (such as loss of power, fan belt failure, etc.) the control system shall assume a normal shutdown condition for the air handling unit and it shall not restart without a normal start command from the operator interface.

3.1.2. Chilled Water Coil Control

The chilled water control valve shall be modulated to maintain the coil discharge temperature set point.
3.1.3. **Fan Airflow Control**

The air handling unit fan maintains a constant airflow quantity. The supply duct airflow station measures the supply airflow and adjusts the fan speed controller to maintain set point.

3.1.4. **Humidifier Control**

The output from the humidification controller is fed to the humidifier steam control valve to maintain a humidification set point.

Supply duct mounted humidity transmitter senses the humidity in the main supply duct. Should it rise above 85% RH the output of the humidifier shall be limited to prevent condensation.

3.1.5. **Pre-heat Coil Control**

The output from the zone heating controller modulates the reheat coil control valve to maintain heating set point.

The heating set point is automatically set 1°F below the cooling set point by the control system.

3.1.6. **Room Pressures**

The HVAC system is manually balanced to achieve the desired room pressure differential. No dynamic control of room pressures is provided.

All rooms as shown on the P&IDs have their room differential pressures monitored by local differential pressure transmitters.

These transmitters send signals to the control system for monitoring, trending and alarming.

Software timers are incorporated to prevent nuisance alarms when doors open and close under normal operations.

3.2. **CONSTANT AIR VOLUME BOXES**

3.2.1 **Constant Volume Boxes with Hot Water Reheat**

The unit mounted controller on the VAV box shall modulate the cooling airflow to maintain the space temperature setpoint as set by the space thermostat. The cooling airflow shall not drop below the scheduled min. airflow.

If room temperature drops below deadband (2 deg. F.) on room temperature setpoint, and airflow is a minimum, then hot water reheat coil shall modulate in order to maintain space temperature set point.

An individual zone sensor (one per zone/box) transmits zone temperature and zone setpoint information to the CAV box controller.

3.3 **Roof Mounted Exhaust Fans**

3.3.1 **Exhaust fans operate 24 hours a day in conjunction with the AHU’s.** If a VFD is present on an exhaust fan it is only to be used for balancing purposes only.

END OF SECTION
# SECTION 230990  TESTING, ADJUSTING, AND BALANCING

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## PART 1. - GENERAL

### 1.1. RELATED DOCUMENTS

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

### 1.2. SUMMARY

Section Includes:

- Balancing Air Systems
  - Constant-Volume Air Systems
  - Variable-Air-Volume Systems
  - Building Pressurization Balancing
Sound Measurement

HEPA Filter Integrity Testing

1.3. **DEFINITIONS**

- **AABC**: Associated Air Balance Council
- **NEBB**: National Environmental Balancing Bureau
- **TAB**: Testing, Adjusting and Balancing
- **TABB**: Testing, Adjusting and Balancing Bureau
- **TAB Specialist**: an entity engaged to perform TAB Work

1.4. **SUBMITTALS**

- **Qualification Data**: Within 10 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article 1.5.
- **Contract Documents Examination Report**: Within 20 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- **Strategies and Procedures Plan**: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article 3.3.
- **Certified TAB reports upon completion of TAB**.
- **Sample report forms prior to commencing TAB**.
- **Instrument calibration reports with final report**, to include the following:
  - Instrument Type and Make
  - Serial Number
  - Application
  - Dates of Use
  - Dates of Calibration

1.5. **QUALITY ASSURANCE**

- **Tab Contractor Qualifications**: Engage an independent TAB entity certified by AABC or NEBB.
- **TAB Field Supervisor**: Employee of the TAB contractor and certified by AABC or NEBB.
- **TAB Technician**: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- **TAB Conference**: Meet with Engineer, Owner, and Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven (7) days' advance notice of scheduled meeting time and location.
Agenda Items

- Review the contract documents examination report.
- Review the TAB plan.
- Discuss and establish coordination and cooperation of trades and subcontractors.
- Discuss and establish coordination of documentation and communication flow.

TAB Report Forms: Use standard TAB contractor's forms approved by Engineer and Owner.

Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6. PROJECT CONDITIONS

Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7. COORDINATION

Notice: Provide input to project master schedule to establish test dates and times.

Perform TAB after leakage and pressure tests on distribution systems have been satisfactorily completed.

PART 2. - PRODUCTS – NOT APPLICABLE

PART 3. - EXECUTION

3.1. EXAMINATION

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.

Examine systems for installed balancing devices, such as gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers.

Verify that locations of these balancing devices are accessible.

Examine the approved submittals for systems and equipment.

Examine design data including system descriptions, statements of design criteria for performance and systems' output, and statements of philosophies about system and equipment controls.

Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

Examine test reports specified in individual system and equipment Sections.

Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

Examine heat-transfer coils for correct piping connections and for clean and straight fins.

Examine operating safety interlocks and controls on HVAC equipment.

Report in a timely fashion deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2. PREPARATION

Prepare a TAB plan that includes strategies and step-by-step procedures.

Complete system-readiness checks and prepare reports. Verify the following:

- Permanent electrical-power wiring is complete.
- Hydronic systems are filled, clean, and free of air.
- Automatic control systems are operational.
- Equipment and duct access doors are securely closed.
- Balance, smoke, and fire dampers are open.
- Isolating and balancing valves are open and control valves are operational.
- Ceilings are installed in critical areas where room pressure differentials are required and that access to balancing devices is provided.
- Windows and doors can be closed so indicated conditions for system operations can be met.
- Prior to testing vibration bases, verify that pumps/fans have been properly aligned and balanced to final requirements.
- Prior to conducting HEPA filter integrity testing, ensure air systems have been balanced to final requirements.
- Prior to performing sound measurements, ensure air systems have been balanced to final requirements.
- Prior to testing purity of clean compressed air and other high purity compressed gases, ensure that systems have been installed and cleaned in accordance with NFPA-99 and CGA guidelines. Ensure filters are clean and in place.

3.3. GENERAL PROCEDURES FOR TESTING AND BALANCING

Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA’s "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
After testing and balancing, close probe holes in ducts.

Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings. Do not mark until final balance report has been submitted and approved by the owner.

3.4. **GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**

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. When comparing volumes, correct for temperature.

Prepare schematic diagrams of systems' "as-built" duct layouts.

For variable-air-volume systems, develop a plan to simulate diversity.

Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

Verify that motor starters are equipped with properly sized thermal protection.

Check condensate drains for proper connections and function.

Check for proper sealing of air-handling-unit components.

Verify that air duct system is sealed and has been pressure tested as specified in Division 23 Section "Metal Ducts."

3.5. **PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS**

Adjust fans to deliver total indicated airflows.

Measure total airflow by Pitot-tube traverse.

Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Where airflow stations are installed verify accuracy of measured values against pitot traverse.

Measure static pressure directly at the fan outlet or through the flexible connection.

Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

Report the cleanliness status of filters at the time static pressures are measured.

Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
Review Documents to determine variations in design static pressures versus actual static pressures. Recommend adjustments to accommodate actual conditions.

Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. For AHU’s with economizer modulate AHU dampers and measure fan-motor amperage to ensure that no overload will occur.

Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

Measure airflow of submain ducts by Pitot-tube traverse.

Where sufficient space in submain ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

Measure air outlets and inlets without making adjustments.

Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

Adjust supply air outlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than the dampers at air terminals.

Adjust each supply outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

Adjust patterns of adjustable outlets for proper distribution without drafts.

When all supply outlets are within acceptable tolerance, adjust return/exhaust outlets to achieve the desired room pressurization requirements, as described later.

3.6. BUILDING ROOM PRESSURIZATION BALANCING

Schedule a time with the owner when all doors can be kept closed. Typically night or weekend.

Initially balance the supply airflows and exhaust hoods to the quantities shown on the drawings as described above. Then balance the exhaust and return air outlet flows to obtain the required pressurizations as indicated on the drawings.

If return or exhaust outlets do not exist in the space, then readjust the supply air flows to obtain the required pressurizations. Differential pressures are shown on the pressurization plans.

Rebalance and verify the fixed supply or exhaust hood airflows to the quantities shown on the drawings.

Rebalancing of the exhaust and return airflows (or supply airflows, if only hoods exist for exhaust) shall follow several iterations to obtain the required pressurizations as indicated.
When the airflow is in the intended direction and the pressures have been obtained, Owner shall witness a final balance verification of the air system flow quantities and the pressurizations obtained for spaces within the building.

This shall be done by pressure readings to show pressurization and airflow direction between the facility spaces. If complications arise or the pressurization requirements are not obtainable, notify Owner immediately and include a probable cause for the airflow problem. Do not proceed until the problem has been corrected or direction from Owner has been obtained.

If automatic control of supply/return airflows to individual rooms or dynamic room pressure control is employed, activate control loops one at a time in collaboration with control contractor and verify proper control operation and tuning.

3.7. **GENERAL PROCEDURES FOR HYDRONIC SYSTEMS**

Prepare schematic diagrams of systems' "as-built" piping layouts.

Prepare hydronic systems for testing and balancing according to the following.

Open all manual valves for maximum flow.

- Check flow-control valves for specified sequence of operation, and set at indicated flow.
- 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.
- Set system controls so automatic valves are wide open to heat exchangers and coils.
- Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8. **PROCEDURES FOR STEAM SYSTEMS**

Measure and record upstream and downstream steam pressure of pressure-reducing valves.

Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

3.9. **PROCEDURES FOR MOTORS**

**Motors, 1/2 HP and Larger:** Test at final balanced conditions and record the following data:

- Manufacturer's name, model number, and serial number.
- Motor horsepower rating.
- Motor rpm.
- Efficiency rating.
- Nameplate and measured voltage, each phase.
- Nameplate and measured amperage, each phase.
- Starter thermal-protection-element rating.

**Motors Driven by Variable-Frequency Controllers:** Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.
3.10. **PROCEDURES FOR HEAT-TRANSFER COILS**

Measure, adjust, and record the following data for each water coil:
- Entering- and leaving-water temperature.
- Water flow rate.
- Water pressure drop.
- Dry-bulb temperature of entering and leaving air.
- Wet-bulb temperature of entering and leaving air for cooling coils.
- Airflow.
- Air pressure drop.

Measure, adjust, and record the following data for each steam coil:
- Dry-bulb temperature of entering and leaving air.
- Airflow.
- Air pressure drop.
- Inlet steam pressure.

3.11. **PROCEDURES FOR TESTING, ADJUSTING AND BALANCING EXISTING SYSTEMS**

Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
- New filters are installed.
- Coils are clean and fins combed.
- Drain pans are clean.
- Fans are clean.
- Bearings and other parts are properly lubricated.
- Deficiencies noted in the preconstruction report are corrected.

Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

Compare the required airflow of the renovated work to the measured fan airflows, and determine the new fan speed, motor BHP and the face velocity of filters and coils.

Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

If calculations increase or decrease the air flow rates and water flow rates by more than five (5) percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is five (5) percent or less, equipment adjustments are not required.

Balance each air outlet.
3.12. **TOLERANCES**

Set HVAC system's air flow rates and water flow rates within the following tolerances:

Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus five (5) percent.
Air Outlets and Inlets: Plus or minus 10 percent.
Heating-Water Flow Rate: Plus or minus 10 percent.
Cooling-Water Flow Rate: Plus or minus 10 percent.

Note: For air systems that require specific room differential pressures, set return/exhaust as needed to achieve pressure differentials. Minimum differential shall be as shown on the pressurization plan.

3.13. **REPORTING**

Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices.

Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing.

Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures.

Include a list of any deficiencies and problems found in systems being tested and balanced. Provide suggested remedies for noted deficiencies.

Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14. **FINAL REPORT**

General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

Include a list of instruments used for procedures, along with proof of calibration.

Final Report Contents: In addition to certified field-report data, include the following:

- Fan curves.
- Manufacturers' test data.
- Field test reports prepared by system and equipment installers.
- Other information relative to equipment performance; do not include Shop Drawings and product data.
General Report Data: In addition to form titles and entries, include the following data:

- Title page.
- Name and address of the TAB contractor.
- Project name.
- Project location.
- Architect's name and address.
- Engineer's name and address.
- Contractor's name and address.
- Report date.
- Signature of TAB supervisor who certifies the report.
- Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
- Summary of contents including the following:
  - Indicated versus final performance.
  - Notable characteristics of systems.
  - Description of system operation sequence if it varies from the Contract Documents.
- Nomenclature sheets for each item of equipment.
- Data for terminal units, including manufacturer's name, type, size, and fittings.
- Notes to explain why certain final data in the body of reports vary from indicated values by more than the allowable tolerance.
- Test conditions for fans and pump performance forms including the following:
  - Settings for outdoor-, return-, and exhaust-air dampers.
  - Conditions of filters.
  - Cooling coil, wet- and dry-bulb conditions.
  - Fan drive settings including settings and percentage of maximum pitch diameter.
  - Inlet vane settings of fan speeds for variable-air-volume systems.
  - Settings for supply-air, static-pressure controller.
  - Other system operating conditions that affect performance.

System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

- Quantities of outdoor, supply, return, and exhaust airflows.
- Water and steam flow rates.
- Duct, outlet, and inlet sizes.
- Pipe and valve sizes and locations.
- Terminal units.
- Balancing stations.
- Position of balancing devices.
Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

Unit Data:
- Unit identification.
- Location.
- Make and type.
- Model number and unit size.
- Manufacturer’s serial number.
- Unit arrangement and class.
- Discharge arrangement.
- Sheave make, size in inches, and bore.
- Center-to-center dimensions of sheave, and amount of adjustments in inches.
- Number, make, and size of belts.
- Number, type, and size of filters.

Motor Data:
- Motor make, and frame type and size.
- Horsepower and rpm.
- Volts, phase, and hertz.
- Full-load amperage and service factor.
- Sheave make, size in inches, and bore.
- Center-to-center dimensions of sheave, and amount of adjustments in inches.

Test Data (Indicated and Actual Values):
- Total air flow rate in cfm.
- Total system static pressure in inches wg.
- Fan rpm.
- Discharge static pressure in inches wg.
- Filter static-pressure differential in inches wg.
- Preheat-coil static-pressure differential in inches wg.
- Cooling-coil static-pressure differential in inches wg.
- Outdoor airflow in cfm.
- Static Pressure Profile
- Outdoor-air damper position.
- Return-air damper position.
- Vortex damper position (if applicable).

Apparatus-Coil Test Reports:

Coil Data:
- System identification.
- Location.
- Coil type.
- Number of rows.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fin spacing in fins per inch o.c.</td>
</tr>
<tr>
<td>2</td>
<td>Make and model number.</td>
</tr>
<tr>
<td>3</td>
<td>Face area in sq. ft.</td>
</tr>
<tr>
<td>4</td>
<td>Tube size in NPS.</td>
</tr>
<tr>
<td>5</td>
<td>Tube and fin materials.</td>
</tr>
<tr>
<td>6</td>
<td>Circuiting arrangement.</td>
</tr>
<tr>
<td>7</td>
<td>Test Data (Indicated and Actual Values):</td>
</tr>
<tr>
<td>8</td>
<td>Air flow rate in cfm.</td>
</tr>
<tr>
<td>9</td>
<td>Average face velocity in fpm.</td>
</tr>
<tr>
<td>10</td>
<td>Air pressure drop in inches wg.</td>
</tr>
<tr>
<td>11</td>
<td>Outdoor-air, wet- and dry-bulb temperatures in deg F.</td>
</tr>
<tr>
<td>12</td>
<td>Entering-air, wet- and dry-bulb temperatures in deg F.</td>
</tr>
<tr>
<td>13</td>
<td>Leaving-air, wet- and dry-bulb temperatures in deg F.</td>
</tr>
<tr>
<td>14</td>
<td>Water flow rate in gpm.</td>
</tr>
<tr>
<td>15</td>
<td>Water pressure differential in feet of head or psig.</td>
</tr>
<tr>
<td>16</td>
<td>Entering-water temperature in deg F.</td>
</tr>
<tr>
<td>17</td>
<td>Leaving-water temperature in deg F.</td>
</tr>
<tr>
<td>18</td>
<td>Inlet steam pressure in psig.</td>
</tr>
<tr>
<td>19</td>
<td>Test Data (Indicated and Actual Values):</td>
</tr>
<tr>
<td>20</td>
<td>Total air flow rate in cfm.</td>
</tr>
<tr>
<td>21</td>
<td>Entering-air temperature in deg F.</td>
</tr>
<tr>
<td>22</td>
<td>Leaving-air temperature in deg F.</td>
</tr>
<tr>
<td>23</td>
<td>Air temperature differential in deg F.</td>
</tr>
<tr>
<td>24</td>
<td>Entering-air static pressure in inches wg.</td>
</tr>
<tr>
<td>25</td>
<td>Leaving-air static pressure in inches wg.</td>
</tr>
<tr>
<td>26</td>
<td>Air static-pressure differential in inches wg.</td>
</tr>
<tr>
<td>27</td>
<td>Manifold pressure in psig.</td>
</tr>
<tr>
<td>28</td>
<td>High-temperature-limit setting in deg F.</td>
</tr>
<tr>
<td>29</td>
<td>Operating set point in Btu/h.</td>
</tr>
<tr>
<td>30</td>
<td>Motor voltage at each connection.</td>
</tr>
<tr>
<td>31</td>
<td>Motor amperage for each phase.</td>
</tr>
<tr>
<td>32</td>
<td>Heating value of fuel in Btu/h.</td>
</tr>
</tbody>
</table>

**Fan Test Reports**: For supply, return, and exhaust fans, include the following:

**Fan Data:**
- System identification.
- Location.
- Make and type.
- Model number and size.
- Manufacturer's serial number.
Arrangement and class.
Sheave make, size in inches, and bore.
Center-to-center dimensions of sheave, and amount of adjustments in inches.

Motor Data:
Motor make, and frame type and size.
Horsepower and rpm.
Volts, phase, and hertz.
Full-load amperage and service factor.
Sheave make, size in inches, and bore.
Center-to-center dimensions of sheave, and amount of adjustments in inches.
Number, make, and size of belts.

Test Data (Indicated and Actual Values):
Total airflow rate in cfm.
Total system static pressure in inches wg.
Fan rpm.
Discharge static pressure in inches wg.
Suction static pressure in inches wg.

Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

Report Data:
System and air-handling-unit number.
Location and zone.
Traverse air temperature in deg F.
Duct static pressure in inches wg.
Duct size in inches.
Duct area in sq. ft.
Indicated air flow rate in cfm.
Indicated velocity in fpm.
Actual air flow rate in cfm.
Actual average velocity in fpm.
Barometric pressure in psig.

Air-Terminal-Device Reports:

Unit Data:
System and air-handling unit identification.
Location and zone.
Apparatus used for test.
Area served.
Make.
Number from system diagram.
Type and model number.
Size.
Effective area in sq. ft.

Test Data (Indicated and Actual Values):
Air flow rate in cfm.
Air velocity in fpm.
Preliminary air flow rate as needed in cfm.
Preliminary velocity as needed in fpm.
Final air flow rate in cfm.
Final velocity in fpm.
Space temperature in deg F.

System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

Unit Data:
System and air-handling-unit identification.
Location and zone.
Room or riser served.
Coil make and size.
Flowmeter type.

Test Data (Indicated and Actual Values):
Air flow rate in cfm.
Entering-water temperature in deg F.
Leaving-water temperature in deg F.
Water pressure drop in feet of head or psig.
Entering-air temperature in deg F.
Leaving-air temperature in deg F.

Instrument Calibration Reports:

Report Data:
Instrument type and make.
Serial number.
Application.
Dates of use.
Dates of calibration.
3.15. **INSPECTIONS**

**Initial Inspection:**

After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

Check the following for each system:

- Measure airflow of at least 10 percent of air outlets.
- Measure water flow of at least five (5) percent of terminals.
- Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- Verify that balancing devices are marked with final balance position.
- Note deviations from the Contract Documents in the final report.
- Measure airflows at or close to flow stations. Compare readings to BMS indicator.

**Final Inspection:**

After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.

The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Engineer.

Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the total measurements that can be accomplished in a four (4) hour period. All room pressures shall be verified where room pressures are critical.

If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

- Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

Prepare test and inspection reports.

3.16. **ADDITIONAL TESTS**

Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION
SECTION 260500
BASIC ELECTRICAL REQUIREMENTS

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23, 26, 27, 28, 33, and 48. The requirements of this section apply to all other Division 23, 26, 27, 28, 33, and 48 Sections.

Drawings and Specification Sections are grouped similar to the Construction Standards Institute's Master format and to accommodate common construction industry practice. This grouping does not refer whatsoever as to what type of seller, craft, trade, employee or subcontractor should furnish the work and/or materials. Such grouping is not to be construed as an assignment of labor or material to any particular craft or seller.

Contract Drawings are in part schematic, intended to convey the scope of work and indicate the general layout, design and arrangement. Contract Drawings are not to be scaled.

Follow Contract Drawings in laying out the work. Check and be familiar with Shop Drawings and Coordination Drawings affecting spaces in which the work will be installed.

Related Sections: The following sections contain requirements that relate to this section:

Division 26 - Basic Electrical Materials and Methods, for materials and methods common to the remainder of Division 23, 26, and 28 plus general related specifications.

1.2. JOB CONDITIONS

Maintain a superintendent or foreman for each trade at the jobsite when work is being performed and when required for coordination between trades.
Coordinate routing of conduit, cable trays, lighting, power devices, special system devices, piping, ductwork, etc., to allow installation and service access. Refer conflicts to the Owner or Owner's Representative for final decisions as to right-of-way.

1.3. CODES, ORDINANCES, AND REGULATIONS

Comply with applicable national, state, and local codes, ordinances, and regulations, including but not limited to the following:

- IEEE Institute of Electrical and Electronic Engineers Standards and Recommendations
- UL Underwriters Laboratory Compliance
- NFPA National Fire Protection Association Standards
- AEIC Association of Edison Illuminating Companies
- ICEA Insulated Cable Engineers Association
- NEMA National Electrical Manufacturers Association
- EIA Electronic Industries Association
- ASTM Applicable American Society of Testing and Materials Standards
- ANSI Applicable American National Standards Institute Standards
- AWS American Welding Society
- OSHA Occupational Safety and Health ACT Regulations
- EPA Environmental Protection Agency Regulations
- ADA American with Disability Act
- FDA Food and Drug Administration

1.4. START-UP, ADJUSTMENT, AND INSTRUCTION

Prior to final acceptance, operate systems and equipment for a minimum of 72 continuous hours and until normal operating conditions are achieved, as approved by the Owner. Contractor shall clean all systems and equipment.

Demonstrate to and instruct the Owner in the proper operation of all systems and equipment.

Adjust all systems and equipment to provide operation shown and described on the drawings and specified herein. Properly align and adjust all equipment to eliminate excess noise and vibration as acceptable to the Owner.

Should, in the opinion of the Owner or Engineer, the Contractor be unable or unwilling to properly adjust the work, or instruct the Owner in the proper operation of the equipment and systems, adjustment and instruction will be provided by the Owner at the rate of $125.00 per hour with the cost of these services to be paid by the Contractor.

1.5. WARRANTIES AND GUARANTEES

In addition to warranties called for in other sections of these specifications, work shall be guaranteed against defect due to faulty installation, manufacture, and component design.
Warranties and guarantees shall be for a period of not less than one year, beginning on the later date of final acceptance by Owner, or equipment start-up.

Upon written notice from the Owner or Engineer, promptly remedy, without cost to the Owner, any defects occurring or discovered during the guarantee period.

1.6. **SUBMITTALS**

**General**

Provide submittals of material or equipment in accordance with the Submittal Requirement Schedule at the end of this specification section.

Some sections have very specific submittals, not indicated in this section, and therefore are indicated in that specific specification section. A submittal is required if an "X" is indicated for that column and item.

**Acceptable Manufacturers**

Subject to compliance with the requirements of the individual specification sections, provide materials and equipment from the indicated manufacturers only.

Submittals of material or equipment manufactured by other than those indicated will be returned.

**Submittal Procedures**

**Coordination:** Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.

Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

The Owner or Owner's Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

**Processing:** Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.

Allow ten working days for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals.

The Owner or Owner's Representative will promptly advise the Contractor when a submittal being processed must be delayed for coordination.

If an intermediate submittal is necessary, process the same as the initial submittal.

Allow ten working days for reprocessing each submittal.

No extension of contract time will be authorized because of failure to transmit submittals to the Owner or Owner's Representative sufficiently in advance of the Work to permit processing.
Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

Provide a space approximately 4” x 5” on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

Submittal which do not have the Contractor's review and approval markings will be returned without review.

Provide a space approximately 4” x 5” on the label or beside the title block on Shop Drawings to record the Owner's or Owner's Representative review and approval markings and the action taken.

Include the following information on the label or title block for processing and recording action taken.

- Project name
- Date
- Name and address of Owner
- Name and address of Engineer
- Name and address of Contractor
- Name and address of subcontractor
- Name and address of supplier
- Name of manufacturer
- Number and title of appropriate Specification Section
- Drawing number and detail references, as appropriate

Submittal Transmittal: Package each submittal appropriately for transmittal and handling.

Transmit each submittal from Contractor to Owner or Owner's Representative using a transmittal form. Submittals received from sources other than the Contractor will be returned without action.

Submittals: Submit one electronic copy of each required submittal in PDF format.

The Engineer will mark and return one copy in PDF format with action taken and corrections or modifications required. Owner will retain one electronic copies of each.

On the transmittal record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations.

Include Contractor's certification that information complies with Contract Document requirements, otherwise submittal will be returned with no action taken.

Schedules: Project schedules indicating proposed work phases and sequences. Include in schedule as a minimum, approvals, equipment release, delivery, fabrication, equipment setting, startup, punch, and cleanup.

Submittal Schedule

Prepare and submit a complete schedule of submittals.

Coordinate submittal schedule with the Contractor's construction schedule.
Prepare the schedule in chronological order. Provide the following information:

- Scheduled date for the first submittal
- Related Section number
- Submittal category
- Name of subcontractor
- Description of the part of the Work covered
- Scheduled date for resubmittal
- Anticipated date for Engineer's final release or approval

Distribution: Following response to initial submittal, print and distribute copies to the Engineer, Owner, subcontractors, and other parties required to comply with submittal dates indicated.

When revisions are made, distribute to the same parties.

Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule to all parties involved.

1.6.1. Review Action

The Contractor is responsible for all data and information on submittals, including quantities, sizes, dimensions, and compliance with the Drawings and Specifications.

Checking by the Owner or Owner's Representative is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents.

Any action shown is subject to the requirements of the Drawings and Specifications.

Contractor is responsible for dimensions and quantities which shall be confirmed at the jobsite, and fabrication process and techniques of construction.

Except for submittals for record, information for similar purposes, where action and return is required or requested, the Owner will check each submittal, mark to indicate action taken, and return promptly.

Compliance with specified characteristics is the Contractor's responsibility.

1.6.2. Shop Drawings

Submit information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents.

Do not reproduce Contract Documents (unless authorized by the Owner/Engineer) or copy standard information as the basis of Shop Drawings.

Standard information prepared without specific reference to the Project are not considered Shop Drawings.

Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings, and directions for installation of anchorages.
Include as a minimum the following information on drawings or diagrams:

- Dimensions
- Identification of products and materials included
- Compliance with specified standards
- Notation of coordination requirements
- Notation of dimensions established by field measurement
- Clearances for access and service

Sheet Size: Except for templates, patterns and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2" x 11", but no larger than 30" x 42".

Initial Submittal: Where Contractor desires product specific information or preliminary review prior to processing of final submittal. Submit black-line prints for the Owner's review.

Final Submittal: Submit black line prints and additional prints, required for maintenance manuals, plus the number of prints needed for general distribution.

One of the prints returned shall be marked-up and maintained as a "Record Document".

Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.6.3. Product Data

Collect Product Data into a single submittal for each element of construction or system.

Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.

Product Data Information: includes catalog cuts, sketches, or bulletins indicating performance characteristics, features of equipment, controls, instrumentation, valving, equipment dimensions, materials of construction, estimated weight of unit (shipping, installed, and operating), heat rejection load when operating, auxiliaries, specialties, or accessories furnished, roughing-in or anchor diagrams and templates, manufacturer's installation instructions, service clearance requirements, standard color charts, and wiring diagrams.

Schematic Drawings shall include elevation and plan views, and indicate all connections, attachments, and details to indicate field required general details of assembly, etc.

Wiring diagrams shall detail wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information with above product data:

- Manufacturer's printed recommendations
- Compliance with recognized trade association standards
- Compliance with recognized testing agency standards
- Application of testing agency labels and seals
- Notation of dimensions verified by field measurement
- Notation of coordination requirements

Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
Preliminary Submittal: (Where Contractor desires product specific information or preliminary review prior to processing of final submittal.) Submit a preliminary single-copy of Product Data where selection of options is required.

Submittals: Submit one electronic copy of each required submittal in PDF format. The Engineer will mark and return one copy in PDF format with action taken and corrections or modifications required. Owner will retain one electronic copies of each.

Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities.

Show distribution on transmittal forms.

Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's possession.

Do not permit use of unmarked copies of Product Data in connection with construction.

1.6.4. Record Documents

General: Do not use record documents for construction purposes; protect from deterioration and loss, by keeping them in a secure, fire-resistive location; provide access of record documents for the Owner's reference during normal working hours.

Record Drawings: Maintain a clean, undamaged set of blue or black line prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies from the Work as originally shown.

Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings.

Give particular attention to concealed elements that would be difficult to measure and record at a later date.

Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

Note related Change Order, RFI, Change in Work Request, Engineer Change Notice or Architects Supplemental information numbers where applicable.

Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

Prepare CAD record documents (using AutoCAD) including indication of the following installed conditions:

Major raceway systems, size and location, for both exterior and interior; locations of control devices; filters, distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

Equipment locations (exposed and concealed), dimensioned from prominent building lines.

Approved Substitutions, contract modifications, actual equipment and materials installed.
1.6.5.  **Maintenance Manuals**

**Maintenance Manuals:** Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2", 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:

- Manufacturer name, Model number, and Serial number
- Shop Drawings and Product Data
- Wiring diagrams
- Copies of warranties
- Inspection procedures
- Emergency instructions
- Parts list
- Recommended spare parts list
- Recommended "turn around" cycles
- Certification numbers, reports, forms, and other information if applicable
- Test protocols, or acceptance criteria if applicable

Prepare maintenance manuals to include the following information for equipment and all auxiliary items:

- Description of function, normal operating characteristics and limitations, performance, engineering data and tests, control system documentation, and complete nomenclature and commercial numbers of replacement parts.

- Instructions for installation.

- Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
- Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions; instrument calibration and test procedures.

- Servicing instructions and lubrication charts and schedules.

- Spare parts list shall be furnished listing all parts for equipment. Indicate part number and generic description of equipment part manufacturer. List(s) shall include parts for all peripheral equipment (i.e., vacuum pumps, microprocessor package, auxiliary equipment, etc.).

**Recommended Spare Parts List:** Vendor shall furnish an itemized, firm price quote list of all recommended spare parts for quoted equipment. Indicate delivery time required if not a stock item.

Indicate part number and generic description of both equipment supplier and original part manufacturer if other than supplier. Spare parts list(s) shall include parts for all peripheral equipment (i.e., microprocessor package, auxiliary equipment, etc.).

Before Substantial Completion, when each installation that requires submittal of operating and maintenance manuals is nominally complete, submit two draft copies of each manual to the Owner or Owner's Representative for review. Include a complete index or table of contents of each manual.

The Owner will return one copy of the draft with comments within 15 days of receipt.
Submit one copy of data in final form at least 15 days before Contractor's request for final observation. This copy will be returned within fifteen days after final observation, with comments.

After final observation make corrections or modifications to comply with the Owner's comments. Submit one copy of each approved manual in electronic PDF format to the Owner within 15 days of receipt of the Owner's comments.

1.7. **DELIVERY, STORAGE, AND HANDLING**

Deliver products, materials and equipment marked with product names, model numbers, types, grades, compliance labels, and other information needed for identification. Inspect items for shipping damage and refuse, return, or refurbish items to the satisfaction of the Owner.

Maintain delivery records for inventory control and for use in processing payment request vouchers. Crosscheck delivery records with project schedule so as to eliminate work stoppages due to material shortages.

Store products, materials, and equipment in a manner to prevent damage and degradation. Store items on skids or pallets, elevated above the floor or grade.

Store items subject to moisture damage in a dry location. Retain protective shipping covers, crates, and cartons during storage. Protect items from contamination by jobsite dirt and debris and other foreign matter. Segregate items into groups of like type for jobsite storage.

Provide a secure, fenced, and lighted area for outside jobsite storage.

Handle products, materials, and equipment in accordance with manufacturer's recommendations and recognized industry standards. Utilize lifting lugs, and designated lift points when hoisting equipment.

Always handle, transport, and position items carefully to prevent damage during construction.

After placement or installation, cover items with tarps or sheeting where required protecting from damage during construction.

Refer to individual specifications for additional delivery, storage, and handling requirements for specific materials and pieces of equipment.

**PART 2. - PRODUCTS – NOT APPLICABLE**

**PART 3. - EXECUTION**

3.1. **INSTALLATIONS**

**General:** Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. When coordination requirements conflict with individual system requirements, refer conflict to the Owner.
The electrical circuits, components, and controls for all equipment are selected and sized, based on the equipment specified. If substitutions and/or equivalent equipment are furnished, it shall be the responsibility of all parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity or more materials or labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then it shall be the responsibility of the parties involved in providing the substitute and/or equivalent items of equipment to provide all compensation for additional charges made for the proper rough-in, circuitry and connections for the equipment furnished. No additional charges above the Base Bid shall be allowed for such revisions.

**SUBMITTAL REQUIREMENTS SCHEDULE**

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<th>Coord. Draw</th>
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An "x" in the 'other' column indicates additional submittals are required and are specified within that specific specification section.

END OF SECTION
SECTION 260505  BASIC ELECTRICAL MATERIALS AND METHODS

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PART 1.- GENERAL

1.1. RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 26.

The requirements of this section apply to all other Division 26 Sections.

The Specifications and Drawings together comprise a complete set of documents.

They are organized in general by discipline, but this is not meant as an assignment of work.

The Contractor is responsible to coordinate all work shown in all Drawings and Specifications.

Where conflicts exist within the documents, it is assumed that the more expensive alternative is part of the Contract.

Project No. 162848.00  260505 - 1 of 11  Basic Electrical Materials and Methods
Rev. A, 03/16/17
Issue for Bid
1.2. QUALITY ASSURANCE

Where Codes and Standards are referenced, they are assumed to be the latest edition available at the start of construction or the edition enforced by the Authority Having Jurisdiction.

Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown. Provide UL label on each fire-rated access door.

Electrical Code Compliance: Comply with applicable requirements of NFPA 70 “National Electrical Code”


UL Compliance: Provide electrical products and materials that are UL listed and labeled.

1.3. JOB CONDITIONS

General: The following requirements apply:

Protect completed facilities and services from construction dust and debris and undue construction noise. Prevent the entrance of rainwater or formation of condensation into the completed facility. Provide description of proposed means to meet these requirements as part of pre-construction submittals.

No food or drink, other than water, shall be permitted in pharmaceutical production spaces or laboratory spaces at any point during construction.

Protect work, materials and equipment from damage before, during, and after installation. Cap or plug temporary openings.

Protect system piping, ductwork, conduit, etc., from accumulation of debris or water. Ensure that water is not trapped in wrappings of equipment and that heaters are placed in equipment in areas without temperature or humidity control.

Repair or restore rusted or otherwise damaged materials and equipment to "as new" condition as acceptable to the Owner.

Coordinate routing of piping, ductwork, conduit, etc., to allow installation and service access. Refer conflicts to the Owner or Owner’s Representative for final decisions as to right-of-way.

Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

Prepare coordination drawings as part of coordination effort between trades.
Drawings shall indicate work of all trades with elevations of all routings demonstrating coordination. Submit drawings to Engineer for review, but responsibility for coordination rests with the Contractors.

Keep construction areas clean and free of debris. At the end of each day, sweep interior areas clean with a broom.

Coordinate sequencing with all other trades, construction phasing, and Owner occupancy.

Prior to commencing on site construction activities, provide a schedule of all work on the project that shows sequencing between trades and review periods for submittals.

Submit schedule to Engineer for review, and keep updated throughout project.

Rework or modify work installed out of proper sequence that causes conflict with the installation of other work.

**Utility Shutdowns**

Include all major utility startups and shutdowns in construction schedule.

Locate, identify, and protect electrical services passing through construction area and serving other areas. Maintain services to areas outside Project’s limits. When services must be interrupted, install temporary services for affected areas.

Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than seven (7) days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager written permission.
3. Comply with NFPA 70E.

All work that may affect a utility shall be performed in accordance to a written method of procedure (MOP). This document shall be prepared by the Contractor and include overall sequence of events, emergency contacts, and procedure to restore utility if unexpected conditions occur.

**Uncharted or Incorrectly Charted Utilities:** Contact utility Owner immediately for instructions.

Use of explosives is not permitted.

**PART 2. - PRODUCTS**

**2.1. EQUIPMENT MANUFACTURER’S NAMEPLATE DATA**

**Nameplate:** For each piece of electrical equipment provide a permanent nameplate-indicating manufacturer, product name, model number, serial number, capacity, operating and/or power characteristics, labels showing compliances with testing, and similar essential data. Locate nameplates in an easily observed accessible location.

**2.2. MISCELLANEOUS MATERIAL**

**Steel Plates, Shapes, Bars, and Bar Grating:** ASTM A 36.

**Cold-Formed Steel Tubing:** ASTM A 500.
Hot-Rolled Steel Tubing: ASTM A 501.

Steel Pipe: ASTM A 53, Schedule 40, welded.

No Shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout, recommended for interior and exterior applications.

Fasteners: Zinc-coated, type, grade, and class as required.

2.3. MISCELLANEOUS LUMBER

Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules.

Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32”.

2.4. SEALANTS

Elastomeric Sealants

One-part, nonacid-curing, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

Products: Subject to compliance with requirements, provide one of the following:

"Dow Corning 786," Dow Corning Corp.
"SCS1001," General Electric Co.
"860 Tru-White," Pecora Corp.

Acrylic-Emulsion Sealants

One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than ±5 percent.

Fire-Resistant Sealants

Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to the Engineer and authorities having jurisdiction.

One-part, fire stopping, mildew-resistant, silicone sealant consisting of one part elastomeric sealant formulated for use in a through-penetration fire stop system for sealing openings around cables, conduit, pipes and similar penetrations through walls and floors.
Products: Subject to compliance with requirements, provide one of the following:

   Hilti
   Specified Technologies, Inc.
   3M Company

2.5. ELECTRICAL CONNECTIONS FOR EQUIPMENT

General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and termination of types indicated.

Connectors and Terminals: Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.

2.6. SUPPORTING DEVICES

Raceway Supports: Bolted conduit clamps, bolted beam clamps, riser clamps, ceiling trapeze hangers, wall brackets, and one-hole and two-hole straps

Fasteners: Types, materials, and construction features as follows:

Expansion Anchors: Carbon steel wedge or sleeve type.

Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

U-Channel Systems: 12 gauge minimum steel channels. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

Lighting Fixture Supports: Comply with requirements stated within this section and specific requirements stated in “Interior Lighting Fixtures, Lamps, and Ballasts”

2.7. ELECTRICAL IDENTIFICATION

Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, self-laminating, wraparound, cable/conductor markers with preprinted or type written number and letter assignments as indicated on drawings or shop drawings.

Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16” minimum thick for signs up to 20 square inches, or 8” in length; 1/8” thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners. Provide nameplates for all electrical distribution equipment; disconnect switches, relay cabinets, and any other item as specifically indicated.
Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50 lb. minimum tensile strength, and suitable for a temperature range from -50°F to 350°F.

Junction Boxes and Outlet Boxes: Emergency circuit junction boxes shall be marked with “EP” with the panel and circuit number indicated. Normal circuit junction boxes shall be marked with panel and circuit number indicated.

2.8. **TEMPORARY UTILITIES**

Temporary Utilities: Provide temporary lighting for all areas of the project, new work areas or demolition work areas, as required to maintain 40 fc lighting level. Provide temporary spider box distribution with six (6) 20A GFI receptacles. Provide supporting trees to keep temporary distribution wiring off of floor.

Do not use Owner’s electrical service for construction power. Obtain permit for temporary electrical service. Schedule temporary power installation with local utility company. Maintain temporary power installation throughout duration of the project. On project completion, remove all temporary power poles, aerial cables, disconnects, spider boxes, etc.

**PART 3. - EXECUTION**

3.1. **EXAMINATION**

Examine work area for suitability of conditions prior to installation of work. Coordinate location of work with adjacent work. Field verify location of work including dimensions and required clearances prior to proceeding with installation.

Where unsatisfactory or unsuitable conditions are encountered, do not proceed until the appropriate persons have been notified and the conditions have been corrected.

3.2. **ROUGH-IN**

Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.3. **INSTALLATIONS**

General: Sequence, coordinate, and integrate the various elements of systems, materials, and equipment. Comply with the following requirements:

- Coordinate electrical systems, equipment, and materials installation with other building components.
- Verify all dimensions by field measurements.
- Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

Install aboveground systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

Install access panel or doors where devices are concealed behind finished surfaces. Access doors shall be sized to allow replacement of the device without damaging the finished surface. Coordinate type of access door with room classification and fire rating of surface.

3.4. **CUTTING AND PATCHING**

**Protection of Installed Work:** During cutting and patching operations, protect adjacent installations.

**General:** Perform cutting and patching in accordance with the following requirements:

Perform cutting, fitting, and patching of electrical equipment and materials required to:

- Install equipment and materials in existing structures.
- Uncover Work to provide for installation of ill-timed Work.
- Remove and replace defective Work.
- Remove and replace Work not conforming to requirements of the Contract Documents.
- Remove samples of installed Work as specified for testing.
- Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer’s observation of concealed Work.

Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

All openings in the roof, for electrical conduits, shall be made weather and watertight using methods approved by the installer of the roofing material so as to not void their warranty.

Openings in fire rated assemblies, made during construction or demolition shall be filled with fire resistant sealant as approved by the authority having jurisdiction.
Patch existing finished and already finished surfaces and building components using new materials matching existing materials utilizing experienced installers. Installers' qualifications depend on the materials and methods required for the surface and building components being patched.

3.5. **SELECTIVE DEMOLITION**

Demolition shall consist of, but not be limited to, the removal of wire, conduit, boxes, lighting fixtures, and other devices as shown on the plans or that is in the way of New Construction. It is the Contractor’s responsibility to maintain circuits and circuitry to keep areas in operation not included in the demolition work but affected by the demolition work.

**General:** Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged.

**Materials and Equipment to Be Salvaged:** Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the Owner.

**Disposal and Cleanup:** Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

**Electrical Materials and Equipment:** Demolish, remove, demount, and disconnect the following items:

- Inactive and obsolete raceway systems, controls, and fixtures.
- Raceways embedded in concrete floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove abandoned materials above accessible ceilings.
- Perform cutting and patching required for demolition and repair to match existing conditions.
- Where portions of circuits are shown to be removed, remove all unnecessary wiring and conduit to the nearest device to remain.
- Where PCB is found on the job site, contractor shall hire the services of a qualified professional to remove and make safe the construction environment. Contractor must obtain written permission from construction manager and owner before proceeding with removal and contact with said qualified professional.

3.7. **ERECTION OF METAL SUPPORTS AND ANCHORAGE**

Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

**Field Welding:** Comply with AWS "Structural Welding Code."

3.8. **APPLICATION OF SEALANTS AND FLASHING**

**Surface Cleaning for Sealants:** Clean surfaces of joints immediately before applying sealants to comply with recommendations of sealant manufacturer.

Apply sealant primer to substrates as recommended by sealant manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing sealant.

**General:** Comply with sealant manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
Comply with recommendations of ASTM C 1193 for use of sealants.

Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.9. ELECTRICAL CONNECTIONS

Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated or authorized otherwise in writing by the Owner or Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

Cover splices with electrical insulating material equivalent to or of greater insulation resistivity rating than electrical insulation rating of those conductors being spliced.

Dress cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

Tighten connectors and terminals; including screws and bolts, in accordance with equipment manufacturers published torque-tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486.

3.10. INSTALLATION OF SUPPORTING DEVICES

Install supporting devices to fasten electric components securely and permanently in accordance with NEC requirements.

Raceway Supports

Conform to manufacturer's recommendations for selection and installation of supports.
Strength of each support shall be adequate to carry present and indicated future load multiplied by a safety factor of at least four (4). Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.

Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

**Vertical Cable Supports:** Install simultaneously with installation of conductors. Cable support shall be installed in accordance with NEC Article 300.19 and shall not damage or excessively reduce the insulation over the conductor where the cable is supported.

**Miscellaneous Supports:** Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

**Sleeves:** Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables. Sleeves shall be standard weight metal pipe.

**Fastening:** Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure. This shall include but not be limited to: conduits, raceways, cables, cable trays, bus ways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components. Method of fastening shall be:

Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on poured-in-place concrete or solid masonry; machine screws, welded threaded studs, or spring-tension clamps on steel; or sheet metal screws on light steel construction. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts on poured-in-place concrete or solid masonry. Attachment to metal roof may be by means of pre-punched tabs, pre-punched holes, sheet metal screws in side of ribs, or toggle bolts in bottom of ribs. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. Do not fasten or support electrical items from ductwork, piping, lay-in ceiling support wires or mechanical equipment.

Fasten manufactured wiring systems to lay-in ceiling support wires with conduit to wire fasteners or by other acceptable means.

Holes cut to depth of more than 1-1/2" in reinforced concrete beams or to depth of more than 3/4" in concrete shall not cut the main reinforcing steel. Fill holes that are not used. Do not use drilled or powder-driven studs in pre-cast, pre-stressed concrete. Do not extend drilled or powder-driven studs more than 1” into post-tensioned concrete.

3.11. **INSTALLATION OF ELECTRICAL IDENTIFICATION**

**Lettering and Graphics:** Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified, indicated, or with previously established identification schemes for the facility's electrical installations. Install numbers, lettering, and colors as approved in submittals and as required by Code.

Use conductors with color insulation factory-applied the entire length of the conductors. The following are acceptable substitutions in lieu of factory-coded wire for sizes larger than #10 AWG:
Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6” from terminal points and in all junction and pull boxes. Apply the last two (2) laps of tape with no tension to prevent possible unwinding. Use 1” wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building. Except as otherwise indicated, provide single line of text, with 1/2” high lettering on 1-1/2” high label (2” high where two (2) lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and submittals.

For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker. Provide copies of all panelboard schedules as part of Project’s Record Documents.

Provide temporary warning signs for exposed electrical equipment during the construction process.

3.12. FIELD QUALITY CONTROL

Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, and then retest to demonstrate compliance.

END OF SECTION
SECTION 260519  LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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PART 1.- GENERAL

1.1. QUALITY ASSURANCE

NFPA Compliance: Comply with NFPA 70 “National Electrical Code”.

UL Compliance: Provide components that are listed and labeled by UL under the following standards:

- UL 44: Thermoset-Insulated Wires and Cables
- UL 83: Thermoplastic-Insulated Wires and Cables
- UL 486A-486B: Wire Connectors
- UL 854: Service Entrance Cables
- UL 1277: Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

NEMA/ICEA Compliance: Provide components which comply with the following standards:

- NEMA WC 70/ICEA S-95-658: Non-shielded Power Cable Rated 2000 Volts or less for the Distribution of Electrical Energy

IEEE Compliance: Provide components that comply with the following standard:

- IEEE SA - 82: Test Procedure for Impulse Voltage Tests on Insulated Conductors
PART 2.- PRODUCTS

2.1. CONDUCTORS AND CABLES

General: Provide conductors and cable suitable for the temperature, conditions and location where indicated.

Conductors: Provide stranded conductors for power, control, and lighting circuits.

Conductor Material: Copper for all wires and cables.

Insulation: Provide THHN/THWN-2 insulation for all conductors size #8 AWG and smaller. For all other sizes, provide XHHW-2 insulation.

Jackets: Factory-applied nylon or PVC external jacketed conductors and cables for pulls in raceways over 100 feet in length, for pulls in raceways with more than three (3) equivalent 90° bends, for pulls in conduits underground or under slabs on grade, and where indicated.

Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. Provide cable UL listed for particular application:

- **NEC Type AC, MC and NM cables are expressly prohibited and shall not be used.**
- **Multi-conductor Flexible Cords (Wet Location):** Type SOW, SJOW, STOW, SJTOW
- **Fire-Rated Cable:** Type MI
- **Variable-Frequency Drive Cable:** 1000V UL Flexible Motor Supply Cable, 600V UL 1277 Type TC-ER, with three stranded circuit conductors, overall shield, and 1 full-sized insulated ground.

2.2. CONNECTORS FOR CONDUCTORS

Provide UL listed factory-fabricated, solderless metal pressure connectors and lugs of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.

Use connectors with temperature ratings equal to or greater than those of the conductors upon which used.

Pressure connectors shall be used to connect conductors to devices with lug-type terminals that are not equipped with saddle straps or equivalent means of retaining conductor strands.

PART 3. - EXECUTION

3.1. WIRING METHOD

Use the following wiring methods as indicated:

- **Conductors:** Install all conductors in continuous raceway.
- **Portable Cord:** For flexible pendant leads to outlets and equipment where permitted by Code and as indicated. Use Type SOW, SJOW, STOW, or SJTOW for all applications.
3.2. **INSTALLATION OF CONDUCTORS AND CABLES**

**General:** Install electrical cables, conductors, and connectors in compliance with NEC.

Coordinate cable installation with other Work.

Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

Conceal all cable in finished spaces.

Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.

Keep conductor splices to a minimum.

Install splice and tap connectors that possess equivalent or better mechanical strength and insulation rating than conductors being spliced.

For conductors #8 AWG and smaller, splice and tap connectors shall be spring connectors with molded vinyl caps.

For conductors #6 AWG and larger, splice and tap connectors shall be split-bolt or compression type installed with hydraulic tool of proper capacity as recommended by the manufacturer for the size of conductor on which the connector is used.

Use splice and tap connectors which are compatible with conductor material.

Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess.

Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there are no bare conductors at the terminal.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values.

Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in UL 486A and UL 486B.

3.3. **FIELD QUALITY CONTROL**

Prior to energizing, check installed conductors and cables with megohm meter to determine insulation resistance levels.

Prior to energizing, test conductors and cables for electrical continuity and for short circuits.

Subsequent to conductors and cable hookups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
TABLE 1: Color Coding for Phase Identification:

Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows. For conductors #4 and larger, provide a minimum of 10 wraps of color coded vinyl tape within 6” of conductor termination points.

<table>
<thead>
<tr>
<th>208Y/120 Volts</th>
<th>Phase</th>
<th>480Y/277 Volts</th>
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<td>Black</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Orange</td>
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<tr>
<td>Blue</td>
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<tr>
<td>White</td>
<td>Neutral</td>
<td>Grey</td>
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<tr>
<td>Green</td>
<td>Ground</td>
<td>Green</td>
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SECTION 260526  GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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PART 2. - PRODUCTS

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2. CONDUCTORS
3. BONDING Connectors, TERMINALS AND CLAMPS

PART 3. - EXECUTION

1. INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS
2. FIELD QUALITY CONTROL

PART 1. - GENERAL

1. QUALITY ASSURANCE

Electrical Code Compliance: Comply with applicable requirements of the Authority Having Jurisdiction and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.

UL Compliance: Comply with applicable requirements of UL Standards No.’s 467, ”Electrical Grounding and Bonding Equipment”, and 869A, ”Electrical Service Equipment”, pertaining to grounding and bonding of systems, circuits and equipment. Provide grounding and bonding products which are UL listed and labeled for their intended usage.


PART 2. - PRODUCTS

1. GROUNDING AND BONDING

The new grounding system consists of the following components:

Equipment grounding conductors in all conduits

Materials and Components

General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, and additional accessories needed for a complete installation. When more than one (1) type of component product meets indicated requirements, selection is the Contractor’s option.
When materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2. **CONDUCTORS**

In all conduits, unless otherwise noted, provide an equipment-grounding conductor sized in accordance with the NEC. Material for conductor shall match building power wiring specified elsewhere.

Where conductors that are part of the grounding system are routed above grade, they shall be protected in conduit.

2.3. **BONDING CONNECTORS, TERMINALS AND CLAMPS**

Provide electrical bonding connectors, terminals, lugs and clamps as recommended by bonding connector, terminal, and clamp manufacturers for indicated applications.

**PART 3. - EXECUTION**

3.1. **INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS**

**General:** Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts.

Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

Where metal conduits contain only grounding conductors, bond both ends of conduit directly to enclosed conductors. Mark these conduits with a 1” wide green band every eight feet on center (minimum one band per section of conduit).

3.2. **FIELD QUALITY CONTROL**

Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms, or less, by driving additional ground rods; then retest for compliance.
Testing of grounding system shall be in compliance with IEEE Standard 81 and shall utilize the “fall of potential” method.

Submit test reports for grounding system before electrical system is energized.

END OF SECTION
SECTION 260533

RACEWAYS

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3.1. WIRING METHOD

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

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

Refer to Specification 016800 Tagging and Identification for tagging and labeling requirements.

1.2. SUMMARY

Section Includes:

- Metal conduits, tubing, and fittings.
- Metal wireways and auxiliary gutters.
- Surface metal and nonmetal raceways.
- Installation requirements for special conditions such as underground, hazardous areas and concrete encased.

1.3. DEFINITIONS

- **NETA**: National Electrical Testing Association
- **NRTL**: National Recognized Testing Laboratory
- **SVR**: Suppressed Voltage Rating
- **SPD**: Surge Protection Device
- **UL**: Underwriters Laboratory

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Raceways

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Issue for Bid
1.4. QUALITY ASSURANCE

NEC Compliance: Components and installation shall comply with locally adopted NFPA 70 National Electrical Code.

NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

OSHA NRTL Compliance and Labeling: Comply with applicable requirements of any OSHA Nationally Recognized Testing Laboratory (NRTL) pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by the NRTL.

1.5. SUBMITTALS

Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.6. DELIVERY, STORAGE, AND HANDLING

Accept conduit on site. Inspect for damage.

Package conduit in 10-foot bundles maximum with conduit and coupling thread protectors suitable for indoor and outdoor storage on both ends of all threaded conduit. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage.

Package plastic-coated, rigid conduit, fittings, and bodies in such a manner as to protect the coating from damage during shipment and storage.

Store conduit above ground on racks in an area protected from weather, moisture or possible damage to prevent corrosion and entrance of debris.

1.7. SEQUENCING AND SCHEDULING

Coordinate with other Work, including metal and concrete deck installation, as necessary to interface installation of electrical raceways and components with other Work.

PART 2. - PRODUCTS

2.1. METALLIC CONDUIT AND TUBING

Rigid Metal Conduit - Steel: ANSI C80.1 and UL 6.

Intermediate Metal Conduit - Steel: ANSI C80.6 and UL 1242.

Electrical Metallic Tubing: ANSI C80.3, and UL 797.

Flexible Metal Conduit (FMC): Galvanized, Zinc Coated, Steel, UL 1.
Liquid-Tight Flexible Metal Conduit (LFMC): UL 360.

2.2. **CONDUIT FITTINGS FOR METALLIC CONDUIT AND TUBING**

Fittings for Metal Conduit: NEMA FB 1 and UL 514B. Alloy steel or die-cast metal type fittings.

Electrical Metallic Tubing Fittings: UL 514B. Fittings shall be alloy steel compression for trade size 1 and smaller. Alloy steel set-screw type is acceptable for trade sizes larger than trade size 1. Cast-metal fittings are not permitted.

Liquid-Tight Flexible Metal Conduit (LFMC) Fittings: NEMA FB 1 and UL 514B. Alloy steel compression type, fittings shall be specifically approved for use with this raceway.

Expansion Fittings: NEMA FB 1 and UL 514B. Provide external bonding or a model with internal bonding across expansion fitting.

2.3. **CONDUIT BODIES**

General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with stainless steel screws.

Metallic Conduit and Tubing: Use metallic conduit bodies with threaded hubs with Rigid Steel and Intermediate Steel conduits. Conduit bodies used with EMT conduit shall be marked for use with EMT conduit.

2.4. **WIREWAYS**

General: UL 870 and NEMA 250. Electrical wireways shall be Type 1 unless otherwise indicated and sized according to NFPA 70.

Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

Wireway Covers: Hinged type

Finish: Manufacturer's standard enamel finish.

PART 3. - EXECUTION

3.1. **WIRING METHOD**

Outdoors: Use the following wiring methods:

- **Concealed Above Grade:** Rigid metal or intermediate metal conduit.
- **Connection to Equipment:** Including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment: Liquid tight flexible metal conduit.
 Indoors: Use the following wiring methods:

- **Exposed (not in Vivarium and/or Barrier):** Rigid metal conduit up to 10’ above finished floor, Electrical metalic tubing above 10’.

- **Exposed (Vivarium and/or Barrier):** Rigid metal conduit. Conduit painted by others to match room finish.

- **Concealed (Above Grade):** Electrical metallic tubing up to 4”, or rigid metal **or intermediate metal conduit** for sizes larger than 4”.

- **Connection from Lighting Fixtures to Branch Circuit Junction Boxes:** Flexible metal conduit not to exceed 6'-0”.

- **Connection to Vibrating Equipment:** Including transformers and hydraulic, pneumatic, or electric solenoid or motor-operated equipment.

  **Dry Locations:** Flexible metal conduit.

  **Where Subject to Water Spray or Dripping Oil, Grease, or Water:** Liquid-tight flexible metal conduit.

**Wireways:** NEMA 1

3.2. **INSTALLATION**

**General:** Install electrical raceways in accordance with manufacturer’s written installation instructions, applicable requirements of NEC, and as follows:

- Minimum size for all conduits shall be 3/4” trade size.

- MC cable may be used for lighting fixtures from final branch circuit junction box to fixture not to exceed 6’ in length, branch circuit wiring from fixture to fixture with MC cable is prohibited.

- Pull boxes shall be installed in each conduit run every 100’ – 150’; and no greater distance than 150’. Contractor shall coordinate pull box locations with access panels in hard lid ceilings. All pull boxes and junction boxes shall be installed in an accessible space.

- The maximum number of bends in any single run of conduit shall not exceed 360° (4-90°) per NEC. All feeder raceways shall not exceed 270° of bends between pull boxes.

- Keep raceways at least 6” away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

- Complete installation of electrical raceways before starting installation of conductors within raceways.

- Provide supports for raceways per National Electrical Code. Conduit shall not be fastened to or supported from ductwork, piping, lay-in ceiling support wires, mechanical equipment, or other conduit.

- Prevent foreign matter from entering raceways by using temporary closure protection.

- Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.

Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel.

Factory elbows may be used in banked runs only where they can be installed parallel.

This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways are of the same size. In other cases provide field bends for parallel raceways.

Join raceways with fittings designed and approved for the purpose. Make raceway terminations tight. Tighten setscrews of threadless fittings with suitable tool.

Where subject to vibration or dampness, use insulating bushings to protect conductors and bonding bushings or wedges to assure electrical continuity of the raceway.

**Elevation of Raceway:** Where possible, install horizontal raceway runs above water and steam piping.

Tape all penetrations through vapor barrier to maintain vapor barrier integrity. Coordinate requirements with vapor barrier installer.

Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends are not visible above the finished slab.

Penetrations through slab using rigid metal requires corrosion protection. Prepare conduit with Scotchrap Pipe Primer and Scotchfill Electrical Insulation Putty or engineering approved equal products.

Provide and apply Scotchrap Corrosion Protection Tape 51 or engineering approved equal product to length of conduit through slab including below grade elbow to nearest underground coupling or PVC adapter.

Installation of corrosion protection tape including layers and overlap shall be per manufacture’s recommendations.

**Stub-up Connections:** Extend conduits through concrete floor for connection to freestanding equipment with an internally threaded coupling for plugs.

Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6” above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs with floor.

**Terminations:** Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box.

Where terminations cannot be made secure with one (1) locknut, use two (2) locknuts – one (1) inside and one (1) outside the box.
Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder.

Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

**Raceway Sealing Fittings:** Install raceway-sealing fittings in accordance with the manufacturers written instructions. Locate fittings at suitable, approved, accessible locations. Fill with UL listed sealing compound after installation acceptance by building inspector and coordination with owner.

For concealed raceways, install each fitting with a blank access cover plate having a finish similar to that of adjacent plates or surfaces.

Access plates installed in a clean-room shall be gasketed stainless steel. Install raceway-sealing fittings at the following points and elsewhere as indicated:

**Pull Wires:** Install pull wires in empty raceways. Use #14 AWG zinc-coated steel or monofilament plastic line having not less than 200 lb. tensile strength. Leave not less than 12" of slack at each end of the pull wire.

**Telephone and Signal System Raceways 2" Trade Size and Smaller:** In addition to the above requirements, install raceways 2" and smaller trade size in maximum lengths at 150 feet and with a maximum of two (2), 90 degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

**Flexible Connections:** Install separate ground conductor across flexible connections.

**Variable Frequency Drive (VFD) Connections:** Install conductors in metal conduit from the output of the VFD to the motor. Power wiring to the motor must have the maximum separation from all other power wiring whether from the same drive or other drives.

Do not run VFD power wiring in the same conduit with other load or control wiring. Control conductors shall be run in separate metal raceways.

**Surface Metal Raceway:** Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.

Select each surface metal raceway outlet box to which a lighting fixture is attached to be of sufficient diameter to provide a seat for the fixture canopy.

Where a surface metal raceway is used to supply a fluorescent lighting fixture having central stem suspension with a back plate and a canopy, with or without extension ring, the back plate and canopy will serve as the outlet box and no separate outlet box need be provided.

Provide surface metal raceway outlet box, in addition to the back plate and canopy, at the feed-in location of each fluorescent lighting fixture having end stem suspension.

Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, provide a back plate slightly smaller than the fixture canopy, and no additional surface mounted outlet box need be installed.
3.3. **ADJUSTING AND CLEANING**

Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION
SECTION 260534  ELECTRICAL BOXES AND FITTINGS

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PART 1.- GENERAL

1.1. QUALITY ASSURANCE

Contractor's Qualifications: Firm with at least three (3) years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

ANSI/UL Compliance: Provide electrical boxes and fittings that are UL listed and labeled. Comply with applicable requirements:

- ANSI/UL 514A Metallic Outlet Boxes
- ANSI/UL 514C Cover Plates for Flush-Mounted Wiring Devices

ANSI/NEMA Compliance: Comply with applicable requirements of:

- ANSI/NEMA OS-1 Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA Compliance: Comply with applicable requirements of:

- NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

PART 2.- PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- Appleton Electric; EGS Electrical Group
- OZ/Gedney; EGS Electrical Group
- RACO; Hubbell Electrical Products

Project No. 162848.00 260534 - 1 of 4 Electrical Boxes and Fittings
Rev. A, 03/16/17 Issue for Bid
2.2. **OUTLET BOXES**

Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations.

Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

**Outlet Box Accessories:** Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and to fulfill installation requirements for individual wiring situations. Choice of accessories is installer's code-compliance option.

2.3. **DEVICE BOXES**

Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations.

Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices.

Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding.

**Device Box Accessories:** Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is installer's code-compliance option.

2.4. **RAIN-TIGHT OUTLET BOXES**

Provide corrosion-resistant cast-metal rain-tight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged water-tight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

2.5. **JUNCTION AND PULL BOXES**

Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

2.6. **BUSHINGS, KNOCKOUT, CLOSURES AND LOCKNUTS**

Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.
PART 3. - EXECUTION

3.1. INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

General: Install electrical boxes and fittings, as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

Provide weather-tight outlets for the interior Vivarium area where surface mounted, interior Barrier area where surface mounted, exterior locations exposed to weather or moisture.

Provide knockout closures to cap unused knockout holes where blanks have been removed.

Install electrical boxes in those locations that ensure ready accessibility to enclosed electrical wiring.

Avoid installing boxes back-to-back in walls. Provide not less than 6" (150 mm) separation in normal applications. Provide not less than 24" (600 mm) separation for acoustic-rated walls.

Avoid installing aluminum products in concrete.

Position recessed outlet boxes accurately to allow for surface finish thickness.

Set floor boxes level and flush with finish flooring material.

Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

For outlet box installation in the vivarium and barrier areas (devices facing into the clean space) the contractor shall seal around the outlet box with a putty or duct sealant compound where back of the box is accessible.

Where wires exit the conduit into the outlet box, the contractor is to seal around the wires with a caulk.

Once the faceplate is installed the contractor will seal around the coverplate with clear silicone caulking. Provide weatherproof, gasketed covers.

For outlet box installation in outside walls (building exterior) the contractor shall seal around the outlet box with a putty or duct sealant compound. Where wires exit the conduit into the outlet box, the contractor is to seal around the wires with a caulk. Provide weatherproof, gasketed covers.

For outlet box installation in fire rated walls/partitions/barriers the contractor shall seal around the outlet box with a fire-rated putty such as 3M Fire Barrier Moldable Putty Pads or equal.

Provide electrical connections for installed boxes.

Subsequent to installation of boxes, protect boxes from construction debris and damage.
3.2. **GROUNDING**

Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION
SECTION 260570  
POWER SYSTEM STUDIES

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1.1. RELATED DOCUMENTS

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

IEEE 399-1997 - Recommended Practice for Industrial and Commercial Power Systems Analysis
NFPA 70E-2015 - Standard for Electrical Safety in the Workplace
NFPA 70 - National Electrical Code
IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings
IEEE 1015 - IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
ANSI C37.13 - IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
ANSI C37.010 - IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI C57.12.00 - Standard General Requirements for Liquid Immersed Distribution, Power and Regulation Transformers
1.2. **SUMMARY**

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

B. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

C. A computer-based, feeder and branch circuit load flow and voltage drop study to determine voltage levels at distribution equipment under ordinary load flow conditions.

D. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3. **DEFINITIONS**

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of one lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4. **QUALITY ASSURANCE**

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

a) Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

B. Specialist Qualifications: Professional electrical engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1.5. **SUBMITTALS**

A. Product Data: For computer software program to be used for studies.

B. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

a) Provide the completed analysis to the Construction Manager, Architect/Engineer.
b) The Contractor must be prepared to submit the combined study report. This includes an initial report; up
to (2) revised reports – at no additional cost to the Owner – to incorporate design revisions, field changes
and address comments by the Engineer; and a final report for record. Each re-submittal must include
formal typewritten responses to comments by the Engineer.

C. Short-circuit study input data, including completed computer program input data sheets.
   a) Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional
      engineer licensed in the state where the project is taking place.
   b) Submit study report for action prior to receiving final approval of the distribution equipment submittals.
      If formal completion of studies will cause delay in equipment manufacturing, obtain approval from
      Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and
      associated characteristics is satisfactory.
   c) Include a one-line diagram on Drawings as a scope document for the short-circuit study.
   d) Revised single-line diagram, reflecting field investigation results and results of short-circuit study.
   e) A computer-based, feeder and branch circuit load flow and voltage drop study to determine voltage
      levels at distribution equipment under ordinary load flow conditions.
   f) Coordination-study input data, including completed computer program input data sheets.
   g) Electronic model and database used to perform studies
   h) Study and equipment evaluation reports.

D. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified
   professional engineer licensed in the state where the project is taking place.
   a) Submit study report for action prior to receiving final approval of the distribution equipment submittals.
      If formal completion of studies will cause delay in equipment manufacturing, obtain approval from
      Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and
      associated characteristics is satisfactory.

E. Arc-flash study input data, including completed computer program input data sheets licensed in the state
   where the project is taking place.
   a) Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
      i) Submit study report for action prior to receiving final approval of the distribution equipment
         submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain
         approval from Architect for preliminary submittal of sufficient study data to ensure that the selection
         of devices and associated characteristics is satisfactory
      ii) Arc-flash hazard warning labels

F. Qualification Data: as required by the “Quality Assurance” Article.
   a) Product Certificates: For study software, certifying compliance with IEEE 399 for short-circuit and
      device coordination analysis; certifying compliance with IEEE 1584 and NFPA 70E for arc-flash hazard
      analysis.

G. Closeout submittals
   a) Operation and Maintenance Data: For the overcurrent protective devices to include in emergency,
      operation, and maintenance manuals.
   b) In addition to items specified in Section 017823 "Operation and Maintenance Data," include the
      following:
   c) The following parts from the Protective Device Coordination Study Report:
   d) One-line diagram.
   e) Protective device coordination study.
   f) Time-current coordination curves.
   g) Power system data
H. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

I. Operation and Maintenance Procedures: provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

PART 2. - PRODUCTS

2.1. COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
   a. SKM Systems Analysis, Inc.
   b. EDSA Micro Corporation.
   c. EasyPower LLC
   d. ETAP / Operation Technology, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Comply with IEEE1584 and NFPA70E

D. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

E. Computer Software Program Requirements
   a. Comply with IEEE 399.
   b. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
   c. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2. REPORT CONTENTS

A. Executive Summary

B. Include a bus-to-bus computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus-to-bus calculation.

C. Load Flow and Voltage Drop Analysis
   a. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.
   b. Significant deficiencies in loading or voltage levels shall be called to attention of the Construction Manager and recommendations made for improvements as soon as they are identified.

D. Short Circuit Study

E. Protective Device Coordination Study

F. Arc Flash Study

G. Discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

H. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
I. One-line diagram, showing the following:
   a. Protective device designations and ampere ratings.
   b. Cable type, size and lengths.
   c. Transformer kilovolt ampere (kVA) and voltage ratings.
   d. Motor and generator designations and kVA ratings.
   e. Switchgear, switchboard, motor-control center, and panelboard designations.
   f. Comments and recommendations for system improvements, where needed.

2.3. SHORT CIRCUIT STUDY REPORT CONTENTS

   A. Protective Device Evaluation:
      a. Evaluate equipment and protective devices and compare to short-circuit ratings.
      b. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
      c. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
      d. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
      e. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

   B. Short-Circuit Study Output:
      a. Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
         i. Voltage.
         ii. Calculated fault-current magnitude and angle.
         iii. Fault-point X/R ratio.
         iv. Equivalent impedance.

2.4. PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

   A. Protective Device Coordination Study:
      a. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
         i. Phase and Ground Relays:
            1. Device tag.
            2. Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
            3. Recommendations on improved relaying systems, if applicable.
         ii. Circuit Breakers:
            1. Adjustable pickups and time delays (long time, short time, ground).
            2. Adjustable time-current characteristic.
            3. Adjustable instantaneous pickup.
            4. Recommendations on improved trip systems, if applicable.
         iii. Fuses: Show current rating, voltage, and class.

   B. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
a. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
b. Terminate device characteristic curves at a point reflecting maximum symmetrical or
asymmetrical fault current to which the device is exposed.
c. Identify the device associated with each curve by manufacturer type, function, and, if
applicable, tap, time delay, and instantaneous settings recommended.
d. Plot the following listed characteristic curves, as applicable:
   i. Power utility's overcurrent protective device.
   ii. Medium-voltage equipment overcurrent relays.
   iii. Medium- and low-voltage fuses including manufacturer's minimum melt, total
        clearing, tolerance, and damage bands.
   iv. Low-voltage equipment circuit-breaker trip devices, including manufacturer's
tolerance bands.
   v. Transformer full-load current, magnetizing inrush current, and ANSI through-fault
      protection curves.
   vi. Cables and conductors damage curves.
   viii. Motor-starting characteristics and motor damage points.
   ix. Generator short-circuit decrement curve and generator damage point.
   x. The largest feeder circuit breaker in each motor-control center and panelboard.
e. Provide adequate time margins between device characteristics such that selective operation is
   achieved.
f. Comments and recommendations for system improvements.

2.5. ARC FLASH STUDY REPORT CONTENTS

A. Arc-Flash Study Output:
   a. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the
      following for each overcurrent device location:
         i. Voltage.
         ii. Calculated symmetrical fault-current magnitude and angle.
         iii. Fault-point X/R ratio.

B. No AC Decrement (NACD) ratio.
   i. Equivalent impedance.
   ii. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical
      basis
   iii. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

C. Incident Energy and Flash Protection Boundary Calculations:
   a. Arcing fault magnitude.
   b. Protective device clearing time.
   c. Duration of arc.
   d. Arc-flash boundary.
   e. Working distance.
   f. Incident energy.
   g. Hazard risk category.
   h. Recommendations for arc-flash energy reduction.

D. Fault study input data, case descriptions, and fault-current calculations including a definition of terms
   and guide for interpretation of the computer printout.
2.6. **ARC FLASH WARNING LABELS**

A. Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis:
   
   i. Premium adhesive weatherable protective polyester overlaminate.
   
   
   iii. Base Material: Printed on 3M .002 Premium White Polyester
   
   iv. Overlaminate: 3M .003 Ultra-Clear Weatherable UV Resistant
   
   v. Adhesive Backing: 3M .0018 Premium Acrylic

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD, APPROPRIATE PPE REQUIRED" and shall include the following information taken directly from the arc-flash hazard analysis:
   
   a. Location designation.
   
   b. Nominal voltage.
   
   c. Arc Flash Boundary in inches
   
   d. Arc Flash Hazard at a working distance of 18 inches in Cal/cm²
   
   e. Shock Hazard when cover is removed in kV
   
   f. Bolted Fault Current in kA
   
   g. Incident energy in "cal/cm square."
   
   h. Limited Approach in inches.
   
   i. Restricted Approach in inches with type of Gloves required.
   
   j. Prohibited Approach in inches with type of Gloves required.
   
   k. Engineering report number, revision number, and issue date.
   
   l. Software used to perform the study (if any)
   
   m. Date study performed

C. Labels shall be machine printed, with no field-applied markings.

D. The proposed vendor shall demonstrate experience in providing equipment labels in compliance with the latest NEC section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

**PART 3. - EXECUTION**

3.1. **EXAMINATION AND POWER SYSTEM DATA**

A. Obtain all data necessary for the conduct of the study.
   
   a. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
   
   b. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support the initial short-circuit and subsequent studies. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field:
   
   a. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
b. Electrical power utility impedance at the service.

c. Power sources and ties.

d. Short-circuit current at each system bus, three phase and line-to-ground.

e. Full-load current of all loads.

f. Voltage level at each bus.

g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

j. Generator short-circuit current contribution data, including short-circuit reactance, sub transient reactance, rated kVA, rated voltage, and X/R ratio.

k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

l. Maximum demands from service meters.

m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

n. Motor horsepower and NEMA MG 1 code letter designation.

o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

p. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

q. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

i. Special load considerations, including starting inrush currents and frequent starting and stopping.

ii. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

iii. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

iv. Generator thermal-damage curve.

v. Ratings, types, and settings of utility company’s overcurrent protective devices.

vi. Special overcurrent protective device settings or types stipulated by utility company.

vii. Time-current-characteristic curves of devices indicated to be coordinated.

viii. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

ix. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

x. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

xi. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

C. Examine Project overcurrent protective device submittals. Proceed with studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.
D. The software model of the electrical distribution system shall include component libraries that accurately reflect the overcurrent behavior of the actual device catalog numbers to be installed. Obtain component libraries directly from the overcurrent device manufacturer when necessary.

3.2. SHORT CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.
B. Calculate short-circuit currents according to IEEE 551.
C. Base study on the device characteristics supplied by device manufacturer.
D. The extent of the electrical power system to be studied is indicated on Drawings.
E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   a. To normal system low-voltage load buses where fault current is 10 kA or less.
F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   a. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   a. Electric utility’s supply termination point.
   b. Incoming switchgear.
   c. Unit substation primary and secondary terminals.
   d. Low-voltage switchgear.
   e. Motor-control centers.
   f. Control panels.
   g. Standby generators and automatic transfer switches.
   h. Branch circuit panelboards.
   i. Disconnect switches.
   j. All other devices which carry a KAIC or KAWC rating including but not limited to VFD’s, disconnect switches, buses, breakers, fuses, etc.
I. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 IEEE 241 and IEEE 242.
   a. Transformers:
      i. ANSI C57.12.10.
      ii. ANSI C57.12.22.
      iii. ANSI C57.12.40.
      iv. IEEE C57.12.00.
      v. IEEE C57.96.
   c. Low-Voltage Fuses: IEEE C37.46.
   d. Available short circuit current at utility source and the generator shall e obtained from the utility and generator manufacturer's data (via the Contractor) upon assignments of normal and emergency power source breakers.
   e. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
3.3. **PROTECTIVE DEVICE COORDINATION STUDY**

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. The study shall be based on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
   a. To normal system low-voltage load buses where fault current is 10 kA or less

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:
   a. Device shall not operate in response to the following:
      i. Inrush current when first energized.
      ii. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      iii. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   b. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:
   a. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
   b. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer’s written recommendations and to IEEE 242.

K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   a. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and one line-to-ground fault at each of the following:
   a. Electric utility’s supply termination point.
   b. Switchgear.
   c. Unit substation primary and secondary terminals.
   d. Low-voltage switchgear.
   e. Motor-control centers.
   f. Standby generators and automatic transfer switches.
   g. Branch circuit panelboards.
   h. All other devices which carry a KAIC or KAWC rating including but not limited to VFD’s, disconnect switches, buses, breakers, fuses, etc.
M.  Protective Device Evaluation:
   a.  Evaluate equipment and protective devices and compare to short-circuit ratings.
   b.  Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-
        circuit stresses.
   c.  Any application of series-rated devices shall be recertified, complying with requirements in
        NFPA 70.

3.4.  LOAD FLOW AND VOLTAGE DROP STUDY

A.  Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the
    system. Analyze power system performance two times as follows:
   a.  Include calculations of power flow in all three-phase branch and feeder circuits, calculated
        voltages at each bus and voltage drops of each feeder.
   b.  The analysis shall provide the calculated maximum values of kVA, kW, kVAR, power factor,
        and amperes for each power circuit.
   c.  The calculated power losses in each branch and total system losses shall be provided.
   d.  Prepare the load-flow and voltage-drop analysis and report to show power system components
        that are overloaded, or might become overloaded; show bus voltages that are less than as
        prescribed by NFPA 70.
   e.  A discussion section evaluating the loading and voltage levels for the system shall be provided
        and recommendations included as appropriate to improve system operation.
   f.  Significant deficiencies in loading or voltage levels shall be called to attention of the owner or
        designated representative and recommendations made for improvements at soon as they are
        identified.

3.5.  ARC FLASH HAZARD ANALYSIS

A.  Calculate maximum and minimum contributions of fault-current size.
   a.  The minimum calculation shall assume that the utility contribution is at a minimum and shall
        assume no motor load.
   b.  The maximum calculation shall assume a maximum contribution from the utility and shall
        assume motors to be operating under full-load conditions.
B.  Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution
    system where personnel could perform work on energized parts.
C.  Include medium- and low-voltage equipment locations.
D.  Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash
    boundary, considering incident energy of 1.2 cal/sq.cm.
E.  Incident energy calculations shall consider the accumulation of energy over time when performing arc-
    flash calculations on buses with multiple sources. Iterative calculations shall take into account the
    changing current contributions, as the sources are interrupted or decremented with time. Fault
    contribution from motors and generators shall be decremented as follows:
   a.  Fault contribution from induction motors should not be considered beyond three to five cycles.
   b.  Fault contribution from synchronous motors and generators should be decayed to match the
       actual decrement of each as closely as possible (e.g., contributions from permanent magnet
       generators will typically decay from 10 per unit to three per unit after 10 cycles).
F.  Arc-flash computation shall include both line and load side of a circuit breaker as follows:
   a.  When the circuit breaker is in a separate enclosure.
   b.  When the line terminals of the circuit breaker are separate from the work location.
G.  The actual short-circuit available current is to be determined from a recent short-circuit study.  The flash
    protection boundary will be calculated in accordance with NFPA 70E.
H.  The arc-flash incident energy is to be calculated using the equations in NFPA 70E
I.  Base arc-flash calculations on actual overcurrent protective device clearing time.  Cap maximum clearing
    time at two seconds based on IEEE 1584, Section B.1.2.
3.6. **LABELING**

A. Apply one arc-flash label for 600-V ac, 480-V ac, 208-v and 120-V ac equipment which is part of the study.

B. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.7. **ADJUSTING**

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make modifications to equipment as required to accomplish compliance with short-circuit study.

C. Any changes to engineering documents, as a result of short circuit analysis, shall not result in any additional cost to the Owner.

3.8. **PERSONNEL TRAINING**

A. **Building Operating Personnel Training**: Engage a factory-authorized service representative to train Owner's maintenance personnel in the use of the study results.

B. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
   a. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
   b. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
   c. Adjust, operate, and maintain overcurrent protective device settings.

C. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.
POWER SYSTEM STUDIES (SECTION 260570)

Project Name ________________________________________________

Project Engineer ____________________________________________

Place a check next to each type of system study/analysis desired:

☐ Short Circuit Study

☐ Protective Device Time-Current Coordination Analysis

☐ Load Flow and Voltage Drop Analysis

☐ Power Factor Correction Study

☐ Harmonic Analysis

☐ Switching Transient Analysis

☐ Arc Flash Analysis

☐ Engineering One-lines (As-builts) in the latest edition of AutoCad

☐ Arc Flash Labels (Serialized)

☐ Arc Flash Labels (Non-serialized) (Recommended)

☐ Installation of Arc Flash warning labels

☐ Furnish Arc Flash warning labels

☐ Field survey/verification of existing electrical system

END OF SECTION
SECTION 262726

WIRING DEVICES

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

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

Refer to Specification 016800 Tagging and Identification for tagging and labeling requirements.

1.2. SUMMARY

Section includes:

- Receptacles
- Snap Switches
- Fractional HP Motor Rated Switches
- Covers and Accessories

1.3. DEFINITIONS

NETA: National Electrical Testing Association
NRTL: National Recognized Testing Laboratory
SVR: Suppressed Voltage Rating
SPD: Surge Protection Device
UL: Underwriters Laboratory
1.4. QUALITY ASSURANCE

Source Limitations: Obtain devices, components, and accessories, within same product category, from single source from single manufacturer.

Contractor's Qualifications: Firm with at least three (3) years of successful installation experience on projects utilizing circuit-breaker devices similar to those required for this project.

Codes and Standards

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.

UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

1.5. SUBMITTALS

Product Data: For each type of product.

Samples: One for each type of device and wall plate specified, in each color specified.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Wiring Devices:
Hubbell Wiring Device - Kellems
Leviton
Pass & Seymour/Legrand

2.2. WIRING DEVICES – GENERAL REQUIREMENTS

General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD-1 and WD-6 Standards, and other applicable UL and NEMA standards. Verify color selections with Engineer, Architect, and Owner. Provide devices in colors as indicated below:

Finish Color: White

2.3. RECEPTACLES

Provide receptacles with automatic self-grounding clip, back and side wired with screw-pressure-plate back wire clamp type terminals and additional features. Comply with UL 498 and NEMA WD-1 and WD-6. Receptacles shall have a nylon face, and be rated 20A, 125V, NEMA 5-20R, 2P, 3W.unless otherwise indicated on the drawings. All non-locking receptacles for use in damp or wet locations shall be a listed weather resistant type as required by NEC Article 406.8. Listed devices shall have a WR marking on the face visible when installed.
Industrial and Commercial Applications (Heavy Duty Grade)

Hubbell 5362 Series
Leviton 5362S Series
Pass & Seymour PS5362 Series

2.4. RECEPTACLES, INDUSTRIAL HEAVY-DUTY

Provide pin and sleeve design receptacles conforming to UL 498, 1682 and 1686 C2. Comply with UL 1010 and NEMA FB11 where installed in hazardous locations. Provide features indicated herein or in the drawings.

2.5. GROUND-FAULT INTERRUPTER (GFI) RECEPTACLES

Provide "feed-thru" type ground-fault circuit interrupter, with integral NEMA 5-20R duplex receptacles, ground fault indicator, automatic monitoring/self-testing feature, lockout on line/load reversal, test button, and reset button arranged to protect connected downstream receptacles on same circuit. Provide unit designed for installation in a 2-3/4" deep outlet box without adapter, grounding type, and meeting UL Standard 943 Class A for GFCIs.

Industrial Applications (Heavy Duty Grade)

Hubbell GFRST82 Series
Leviton GFWT2-HG Series
Pass & Seymour 2097HG Series

Damp/Wet Location Applications

Hubbell GFWRST Series
Leviton GFWR Series
Pass & Seymour 2097TRWR Series

2.6. SNAP SWITCHES

Quiet type AC switches, 120/277V, 20A, back and side wired. Comply with UL 20, NEMA WD-1, and Federal Specification WS896E. Switches in clean rooms shall be ‘Decora’ style (Leviton) or ‘Decorator style (Hubbell or P & S).

Industrial Applications (Outside Vivarium and Barrier Only)

Hubbell HBL122* Series
Leviton 122*-2 Series
P&S PS20AC* Series

Inside Vivarium and Barrier

Hubbell DS*20 Series
Leviton 562*-2 Series
P&S 262* Series

* Insert 1 for single pole, 2 for double pole, 3 for three way, and 4 for four way.
2.7. **FRACTIONAL HP MANUAL CONTROLLERS**

Provide single-phase fractional HP manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Controller to become inoperative when thermal unit is removed.

Provide controllers with double break silver alloy contacts, visible from both sides of controller; green pilot lights, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA Type 1 general-purpose enclosure suitable for flush or surface mounting as indicated on drawings; coat with manufacturer’s standard color finish.

2.8. **WIRING DEVICE ACCESSORIES**

**Wall Plates:** Satin finish stainless steel, single and combination, of types, sizes, and with ganging and cutouts as indicated. Comply with UL 514. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plate color to match power source as indicated in wiring device – general requirements except as otherwise indicated below.

- **Pass & Seymour** SS Series
- **Hubbell** SS Series
- **Leviton** 84 Series

Provide plates possessing the following additional construction features:

- **Clean Manufacturing, Weatherproof Switch Plates:** For use inside vivarium and barrier areas.
  - 0.032” thick, type 302 stainless steel with flexible silicone bubble
  - Pass & Seymour 4516.

- **Clean Manufacturing, Weatherproof Receptacle Plates:** For use inside vivarium and barrier areas.
  - Specification grade grey thermoplastic, single lid covers with stainless steel hinges and gasket.
  - Pass & Seymour 3780 Series or equal.
  - Duplex 3780-SC
  - GFCI 3726-SC

**PART 3. - EXECUTION**

3.1. **INSTALLATION OF WIRING DEVICES AND ACCESSORIES**

Install wiring devices and accessories as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.

Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes, and chases for roughing-in of conduit and equipment, check with other contractors to determine exact field location of the above items.

Unless specifically noted on the drawings, check exact direction of door swings so that local switches are properly located on the strike side.
Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.

Install wiring devices after wiring work is completed.

Install wall plates after painting work is completed.

Label each receptacle and lighting switch with panel and circuit number. Use self-adhesive clear polyester, tape labels, laser printed with 1/8" black letters, engraved wall plates or micarta labels.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate. Where ganged switches serving 277V lighting are served by different circuits, so as to result in the voltage between switches exceeding 300V, provide barrier in box per NEC Section 380.2(B).

In locations where several pieces of wall mounted equipment such as wall switches and thermostats are in the same general area, all shall be installed and grouped in a neat, orderly fashion, all of the same horizontal or vertical center line, whichever the case may be.

Variation from this direction shall be approved by the Owner or the Owner’s representative. All receptacles and switches shall be mounted at a height as directed in the drawings.

3.2. **PROTECTION**

Protect installed components from damage. Replace damaged items prior to final acceptance.

3.3. **FIELD QUALITY CONTROL**

Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections in maintained. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device at least six (6) times.

Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

END OF SECTION
For each type of product indicated, include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. **Ambient Temperature Adjustment Information**: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.


4. Time-current limitation curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

5. Coordination charts and tables and related data.

6. Fuse sizes for elevator feeders and elevator disconnect switches.
Operation and Maintenance Data: For fuses 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. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.3 QUALITY ASSURANCE

Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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.

Comply with NEMA FU 1 for cartridge fuses.

UL Compliance and Labeling: Comply with applicable provisions of UL. Comply with UL 248-11 for plug fuses. Provide over current protective devices that are UL listed and labeled.

NEC Compliance: Comply with NEC (NFPA 70) as applicable to construction and installation of fusible devices.

ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.4 PROJECT CONDITIONS

Where ambient temperature to which fuses are directly exposed is less than 40°F (5°C) or more than 100°F (38°C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.5 COORDINATION

Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2. - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:

Cooper Bussman Inc.
Edison Fuse Inc.
Ferraz Shawmut Inc.
Littelfuse Inc.
2.2. **FUSES**

**General:** Except as otherwise indicated, provide fuses of classes or types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

1. **Cartridge Fuses Characteristics:** NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
2. **Plug Fuses Characteristics:** UL 248-11, nonrenewable plug fuses; 125 VAC.

2.3. **FUSE APPLICATIONS**

**Motor Branch Circuits:** Class RK5, time delay.

**Other Branch Circuits:** Class RK5, time delay.

2.4. **TYPICAL FUSE APPLICATIONS**

**Class RK5 Time-Delay Fuses**

Provide UL Class RK5, Bussman symbol FRN-R, time-delay fuses rated 250 volts, 60 Hz, 1/10 - 600 amperes, with 200,000 RMS symmetrical interrupting current rating for protecting motors and electric heating.

**Class RK5 Time-Delay Fuses**

Provide UL Class RK5, Bussman symbol FRS-R, time-delay fuses rated 600 volts, 60 Hz, 1/10 - 600 amperes, with 200,000 RMS symmetrical interrupting current rating for protecting motors and electric heating.

**PART 3.- EXECUTION**

3.1. **EXAMINATION**

Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **INSTALLATION OF FUSES**

Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements.

Comply with NEC and NEMA standards for installation of fuses.
Coordinate with other work, including electrical wiring, as necessary, to interface installation of fuses with other work.

Install fuses in fused devices, if any.

Arrange fuses so rating information is readable without removing fuse.

Install labels complying with requirements for identification specified in Section 016800 – Tagging and Identification and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

3.3 FIELD QUALITY CONTROL

Prior to energization of fusible devices, test devices for continuity of circuitry and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

END OF SECTION
SECTION 262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

INDEX

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

Refer to Specification 016800 Tagging and Identification for tagging and labeling requirements.

Refer to Specification 262813 Fuses for all fuses to be provided with equipment.

1.2. SUMMARY

Section includes:

- Fusible switches.
- Non-fusible switches.
- Enclosures.

CRB Consulting Engineers, Inc.

UTA Vivarium Design Services

University of Texas at Arlington
1.3. **DEFINITIONS**

- **NETA**: National Electrical Testing Association
- **NO**: Normally Open
- **NRTL**: National Recognized Testing Laboratory
- **UL**: Underwriters Laboratory

1.4. **QUALITY ASSURANCE**

**Source Limitations**: Obtain equipment, components, and accessories, within same product category, from single source from single manufacturer.

**Product Selection for Restricted Space**: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

**Contractor's Qualifications**: Firm with at least three (3) years of successful installation experience on projects utilizing circuit-breaker devices similar to those required for this project.

**Codes and Standards**

- **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.

  **UL Compliance**:
  - UL 98: Enclosed and Dead-Front Switches
  - UL 869A: Reference Standard for Service Equipment
  - UL 891: Dead-Front Switchboards
  - UL 977: Fused Power-Circuit Devices

- **ANSI/NEMA Compliance**:
  - NEMA Standard KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 volts maximum)
  - NEMA 250: Enclosures for Electronic Equipment

1.5. **SUBMITTALS**

**Product Data**: For each type of enclosure, switching and overcurrent protective device, surge protection device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

**Qualification Data**: For qualified testing agency.

**Field-Quality Control Reports**

- Test procedures used.
- Test results that comply with requirements.
- Results of failed tests and corrective action taken to achieve test results that comply with requirements.
Operation and Maintenance Data: For equipment and components to include in emergency, operation, and maintenance manuals.

1.6. PROJECT CONDITIONS

Environmental Limitations: Do not deliver or install equipment until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).

1.7. EXTRA MATERIALS

Provide 1/2 pint of touch up paint for every twenty-five (25) enclosures installed, but not less than ½ pint of touch up paint.

Furnish extra materials as indicated in related specification documents.

1.8. DELIVERY, STORAGE, AND HANDLING

Remove loose packing and flammable materials from inside equipment. Install temporary electric heating (250 W per enclosure) to prevent condensation.

Handle and prepare equipment for installation according to NECA 407 and NEMA PB 1.

1.9. WARRANTY

Manufacturer’s Warranty: Manufacturer agrees to repair or replace equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 18 months minimum

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Square D
General Electric
Siemens
Eaton Cutler-Hammer
2.2. **DISCONNECT SWITCHES**

**General:** Provide heavy-duty visible blade, quick-make, quick-break type motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated on drawings. Switches shall be rated 240 or 600 volts as required by the voltage of the circuit.

For motor and motor starter disconnects, provide units with horsepower ratings suitable for the loads. Switches shall have a defeatable door interlock and be lockable in "open" or "closed" position.

All current-carrying parts shall be of high-conductivity copper, designed to carry rated load without heat damage. Switch contacts shall be silver-tungsten type or plated to prevent corrosion, pitting, and oxidation and to assure suitable conductivity.

Switch operating mechanisms shall be designed to retain effectiveness with continuous use at rated capacity without the use of auxiliary springs in the current path.

Provide fusible switches with non-interchangeable feature suitable only for current limiting type fuses.

Switches shall be capable of withstanding the available fault current or let through current before the fuse operates, without damage or change in rating.

Minimum withstand rating for non-fusible disconnect switches shall be 10,000 RMS symmetrical amperes. Minimum withstand rating for fusible disconnect switches shall by 100,000 RMS symmetrical amperes.

**Options and Accessories (where indicated on drawings):**

1. **Auxiliary Contact Kit:** Provide one (1) NO/NC (Form “C”) auxiliary switch contact for remote control/indication for disconnects with Variable Frequency Controller upstream to disconnect control circuit.

2. **Equipment Ground Kit:** Internally mounted and labeled for copper and aluminum ground conductors.

3. **Neutral Kit:** Where applicable provide a 100% rated, internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

2.5. **SWITCH ENCLOSURES**

Prime and coat switchboard with manufacturer's standard finish and color. Provide cabinet type enclosures code-gauge, minimum 16-guage thickness, and rated for environmental conditions at installed location.

1. **Indoor Dry and Clean Locations (excluding Vivarum and Barrier):** NEMA 250, Type 1.

2. **Indoor Dry and Clean Locations (within Vivarum and Barrier):** NEMA 250, Type 4X.

3. **Outdoor Locations:** NEMA 250, Type 3R.

4. **Cleanroom or Wash-Down Areas:** NEMA 250, Type 4X, stainless steel.

5. **Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids:** NEMA 250, Type 12.
PART 3. - EXECUTION

3.1. EXAMINATION

Receive, inspect, handle, and store equipment according to NECA 407 and NEMA PB 1.1.

Examine equipment before installation. Reject equipment that are damaged or rusted or have been subjected to water saturation.

Examine elements and surfaces to receive equipment for compliance with installation tolerances and other conditions affecting performance of the Work.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

General: Provide circuit and motor disconnect switches as indicated and where required by the above code. Comply with switch manufacturers’ printed installation instructions.

Installation: Mount equipment on wall, column, or from an independent support not attached to equipment a maximum of six (6) feet above the floor, unless indicated otherwise in the drawings. Install fuses for each fused safety switch on the Project.

Coordinate fuse sizes with equipment nameplate ratings and manufacturer’s recommendations.

3.3. IDENTIFICATION

Equipment/System Identification: Provide equipment/system identification nameplates in accordance with designations on drawings. Comply with requirements in Section 260500 "Basic Electrical Requirements" and 016800 “Tagging and Identification” for identification of equipment, components, and control wiring.

All wiring and terminal blocks within equipment shall be labeled at each termination with designations used in shop drawing submittals. Labels shall be machine-printed black letters on white background.

3.4. GROUNDING

Provide equipment grounding connections for equipment and enclosures as indicated. Tighten connections to comply with tightening torques specified in UL 486A-486B to assure permanent and effective grounds.

3.5. ADJUSTING AND CLEANING

Adjust operating mechanism for free mechanical movement.

Set field-adjustable circuit-breaker trip ranges as indicated.

Vacuum dirt and debris; do not use compressed air to assist in cleaning.

Touch up scratched or marred surfaces to match original finishes.

3.6. FIELD QUALITY CONTROL

Testing: Inspect switch enclosure, mechanical and electrical connections, fuse installation, and verify type and rating of fuses installed. Label exterior of the switch with the source and load served.
Test operation of switch by manually opening and closing operator with circuit unloaded a minimum of six (6) opening/closing cycles. INITIAL TEST OF SWITCHES SHALL NOT BE DONE UNDER LOAD.

Subsequent to completion of installation, energize circuits and demonstrate capability and compliance with requirements. Correct deficiencies then retest to demonstrate compliance.

Remove and replace defective units with new units and retest.

END OF SECTION
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.

Other Specifications Sections that directly relate to the work of this section include, but are not limited to the following:

1. Section 016800 – Tagging and Identification
2. Section 260570 – Power Systems Studies
3. Section 262816 – Enclosed Switches And Circuit Breakers
4. Section 262913 – Enclosed Controllers

1.2. SUMMARY

Section includes:

1. Current Limiting Circuit Breakers
2. Molded Case Circuit Breakers
3. Insulated Case Circuit Breakers
1.3. **DEFINITIONS**

- **NETA:** National Electrical Testing Association
- **NRTL:** National Recognized Testing Laboratory
- **SVR:** Suppressed Voltage Rating
- **SPD:** Surge Protection Device
- **UL:** Underwriters Laboratory

1.4. **SUBMITTAL REQUIREMENTS**

**Product Data:** For each type of enclosed circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for full rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

**Certification:** Submit certified test data that indicates current-interrupting ratings for each circuit breaker.

**Qualification Data:** For qualified testing agency.

**Field Quality-Control Reports**

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

**Operation and Maintenance Data:** For enclosed circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed circuit breakers.
2. Time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5. **QUALITY ASSURANCE**

**Source Limitations:** Obtain enclosed circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

**Product Selection for Restricted Space:** Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
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.

Contractor's Qualifications: Firm with at least three (3) years of successful installation experience on projects utilizing circuit-breaker devices similar to those required for this project.

Codes and Standards

National Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NFPA 70 (NEC) as applicable to construction and installation of circuit breakers.

UL Compliance: Comply with applicable requirements of UL 489, 943, and 1066 that apply to construction and installation of circuit breakers.

NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No.’s AB 1, 2 and 3, SG 3 and 250.

ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE C37.13, C97.1 pertaining to low-voltage AC power circuit breakers.

1.6. PROJECT CONDITIONS

Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than -22°F (-30°C) and not exceeding 104°F (40°C).

Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than seven (7) days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager written permission.
3. Comply with NFPA 70E.

1.8. DELIVERY STORAGE AND HANDLING

Remove loose packing and flammable materials from inside equipment and devices. Install temporary electric heating (250 W per equipment container) to prevent condensation. Handle and prepare for installation according to NECA 400, 407 and NEMA PB 1 and NEMA PB 2.

1.9. WARRANTY

Manufacturer is Warranty: Manufacturer agrees to repair or replace circuit breakers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 18 months minimum
PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- Square D; Schneider Electric
- Eaton Corporation; Cutler-Hammer Products
- General Electric
- Siemens Energy & Automation, Inc.
- ABB Inc.

Thermal Magnetic Circuit Breaker from the selected manufactures standard offering shall be provide in accordance with the requirements listed below unless noted otherwise within this specification or on the construction drawings.

2.2 MOLDED CASE CIRCUIT BREAKERS

General Requirements: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristic indicated, which comply with manufacturer’s standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

Circuit-Breaker Frame: As required to install within existing panelboards.


Additional MCCB Features and Accessories where indicated in the construction drawings:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.

PART 3. - EXECUTION

3.1. EXAMINATION

Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
Coordinate layout and installation of circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

Install circuit breakers and accessories as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements.

Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to installation of circuit breakers and general wiring practices.

Coordinate with other work, including electrical wiring work, as necessary to interface installation of circuit breaker work with other work.

Fasten circuit breakers without causing mechanical stress, twisting or misalignment exerted by clamps, supports, or cabling.

Set field-adjustable circuit breakers for trip settings as required in accordance with Specification 260570 Power Systems Studies.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.

Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A.

3.3. ADJUST AND CLEAN

Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, clean and adjust units for free mechanical movement.

Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.4. GROUNDING

Provide equipment-grounding connections for circuit breakers as indicated. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5. FIELD QUALITY CONTROL

1. Perform Tests and Inspections: Upon completion of installation and after circuitry has been energized, test capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest for compliance; otherwise, remove and replace with new units, and proceed with retesting. Testing and retesting at no cost to Owner.

END OF SECTION
SECTION 262923

VARIABLE FREQUENCY CONTROLLERS

INDEX

PART 1. - GENERAL

1.1. RELATED DOCUMENTS

1.2. QUALITY ASSURANCE

1.3. SUBMITTALS

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

2.2. VARIABLE FREQUENCY DRIVES

PART 3. - EXECUTION

PART 1. - GENERAL

1.1. RELATED DOCUMENTS

Division 26 - Basic Electrical Requirements and Basic Electrical Materials and Methods Sections apply to work of this section.

1.2. QUALITY ASSURANCE

Variable frequency drives shall be UL labeled or ETL labeled. Variable frequency drives shall meet National Electrical Code requirements for capacitor discharge.

NEMA ICS 7.1
NFPA 70 – National Electric Code
UL 508C – Standard for Safety for Power Conversion Equipment
IEEE 519-2014
FCC Part 15 Subpart J

1.3. SUBMITTALS

General: The variable frequency drive manufacturer shall provide shop drawings, product data, and project information which shall illustrate materials, equipment and workmanship and shall include complete wiring and connection diagrams for the units supplied on this project, control and power wiring, installation instructions, a complete listing of all programming parameters, and operation, maintenance, servicing, and adjustment instructional manuals.

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with the requirements of this specification, provide products by one of the following, or equivalent approved by buyer:

ABB
Yaskowa
2.2. VARIABLE FREQUENCY DRIVES

General: Variable Frequency Drives (VFD) shall provide variable speed operation through the use of an adjustable frequency inverter system.

The units shall be factory furnished and assembled complete with all necessary controls, circuitry, and hardware as required to provide the functions herein specified, and shall only require field connections; from the rated three-phase line voltage power source, from the control circuitry, from motor leads to load side of the variable frequency controller.

Basic Design: Variable Frequency Power and Logic Unit shall be constructed using completely solid state components. Drive logic shall be 100 percent microprocessor based design and include a minimum 16 characters, English language, alpha-numeric display and integral keypad mounted on the front of the drive.

Parameters capable of being displayed shall include speed, speed set point, motor amps, motor volts, line volts, and a chronological fault history. The use of potentiometers located on circuit boards is only allowed if the potentiometers are overridden by the units microprocessor.

The display and keypad shall provide the user access to view VFD status and modify any of its functional parameters in an English Language Format. The VFD shall be of modular design to provide for ease of maintenance.

Unit shall transform 480 volt, 3 phase, 60 Hertz input power into frequency and voltage controlled three-phase output power; suitable to provide positive speed and torque control to standard NEMA B design induction motors.

The front end of the adjustable frequency drive shall convert the AC utility 480 volt, three-phase, 60 Hertz input power to a DC voltage. The following front end shall be acceptable:

Full Wave Diode Bridge front end

Unit displacement power factor shall remain 95 percent or above throughout the entire speed range.

Input power diodes shall have a minimum peak inverse voltage rating, PIV, of 1600 volts. Other semiconductors, such as transistors shall have a minimum PIV rating of 1400 volts.

The final stage shall invert the adjustable level of DC into a frequency and voltage controlled three-phase adjustable AC output. The variable frequency output shall be accomplished by the following:

Sine-coded pulse width modulation scheme.

Power transistors shall be utilized in the inverter. Output devices which require separate commutation, such as SCR's, shall not be acceptable.

Unit shall be capable of operating with the output of the Drive open circuited without causing damage to the Drive or system components.

Total Harmonic Distortion: AC input line reactors shall be supplied on all drives.

Reactors shall be mounted in the drive enclosure or may be installed in a separate, factory integrated enclosure.
All three (3) phases of AC power shall first pass through a minimum three percent impedance AC reactor before the converter section of each drive for enhanced transient suppression and harmonic mitigation.

Internal drive filters used on the DC section, including DC chokes, DC reactors, or DC capacitors, shall not in any way meet this requirement.

**Efficiency:** Minimum acceptable drive efficiency shall be 94% at 100% rated load for 0% to 100% speed.

**Ride Thru:** The VFD shall be capable of riding through a momentary power outage of a minimum of three (3) cycles without causing the drive to shut down.

**Interface:** The microprocessor based operator interface shall at a minimum be capable of displaying VFD frequency or motor load while running and drive status while stopped.

**Memory:** All drive adjustments and custom programming shall be stored in EEPROM (non-volatile memory) which shall protect this information during power outages. The use of batteries shall not be acceptable.

**Coasting Motor:** The VFD shall be capable of starting into a rotating motor at any speed or direction without tripping the drive off-line or damaging the drive and/or pump. This shall be accomplished without shock loading or causing excessive currents in the drive or motor.

**Deceleration:** The drive shall be capable of regenerating power from the motor to the DC bus for controlled deceleration. The circuits shall extend the set deceleration ramp if the bus voltage approaches high limits due to regeneration.

**Control Operating Ambient Temperature & Humidity Range:** 0° C. to 40° C., relative humidity 0% to 95%.

**Enclosures:** Provide variable frequency drive unit in a factory fabricated wall mounted, NEMA 1 enclosure fabricated of cold-rolled steel. The doors shall be flanged, gasketed and mounted on semi-concealed pinion type hinges. The entire enclosure shall be primed and finished with industrial texture paint.

The enclosure shall contain all the air circulating fans and air filters that are required for ventilation and to prevent over-temperature cutouts.

No external fan or heat exchangers shall be required for unit cooling due to enclosure heat buildup.

All components and controls that are integral to the VFD enclosure shall be completely factory installed and pre-wired with labeled cable terminals for field connections.

The power to operate auxiliary equipment, such as fans, shall be derived from within the VFD enclosure and fed from the load side of the main disconnect through correctly sized tap fuses.

**Disconnect and Overcurrent Protection:** A re-settable high magnetic circuit protector (HMCP) shall be integral to the drive enclosure and door-interlocked.

The HMCP shall protect against single phasing, provide short circuit protection, and have adjustable trip settings.

Unit shall be provided with fuses if required to provide minimum AIC rating of 200,000 Amps. Door operator shall include indication of OFF, ON, and TRIPPED status.

Fused or non-fused disconnect switches are not acceptable.
**Drive Output:** Unit shall be capable of operating with the output of the drive open circuited without causing damage to the drive or system components.

**Startup:** Variable frequency drives shall be started and tested after installation by the manufacturer's personnel. Units shall not be energized until checked out by the manufacturer’s authorized service engineer.

**Warranty:** Manufacturer shall provide one (1) year, non-prorated warranty on all parts and labor. Warranty period shall begin on the date of project substantial completion or date the drives are put into service by factory trained personnel required for startup and accepted by the Buyer, whichever occurs later.

**Adjustable Frequency Control**

Stepless throughout speed range under variable torque load on continuous basis.

**Analog Inputs:** The VFD shall be provided with an isolated analog input channel. Each channel shall have an input signal range of 0-5 VDC, 0-10 VDC, or 4-20 mA DC.

**Analog Outputs:** The VFD shall be provided with an independent isolated analog output channel. Each channel shall have an output signal range of 4-20 mA DC.

**Digital Inputs:** The VFD shall be provided with a minimum of four independent digital input channels, two at 24 VDC and two at 115 VAC. Each channel shall be capable of receiving contact closures from 24 VDC and 115 VAC supplies.

**Digital Outputs:** The VFD shall be provided with a minimum of four independent digital output channels, two at 24 VDC and two at 115 VAC. Each channel shall be capable of contact closures from external 24 VDC and 115 VAC supplies.

**Digital Communications:**

The VFD shall be equipped with the proper network interface card and software driver to enable it to directly communicate with building management systems (BMS), process control systems, or other controllers, using that system’s communications protocol. The prescribed network communications protocol shall permit transmission to/from the VFD of control signals, process variables, set points, and configuration settings, and enable remote collection and monitoring of data from the VFD by the control system. Network communications protocol(s) include:

- Fieldbus
- Profibus – DP
- Modbus
- Ethernet/IP
- ControlNet
- DeviceNet
- Universal Remote I/O Link
- DH-485 Network
- DH+ Network

Unit shall be furnished with a resonant frequency lockout of a minimum of two (2) bands to avoid Inverter operation at a critical speed. The bandwidth and placement shall be field-adjustable. When the lower limit of a resonant frequency is reached, the controller shall automatically drive the output of the Inverter to the upper
limit of the same band until the set point controller calls for a further increase in speed. If required, the device
shall be capable of being changed such that the drive will hold at a lower limit until the set point controller calls
for a speed at least as high as the upper limit.

In either case, the jump from the lower limit to the upper limit and back shall be smooth and without hesitation.
The drive shall switch from the low speed end of the skip frequency band to the high speed end when the analog
signal exceeds the half-way point in the programmed band.

Input reference clamp which prevents excessive reference signal from affecting control response. Current and
voltage signals shall be isolated from logic circuitry.

**Automatic Control:** The drive shall be equipped with a Hand-Off-Automatic selector switch or electronic equivalent.

When in the "Automatic" mode the VFD control system shall energize the motor when the speed reference
process variable reaches the start setting. The motor shall be started in a controlled mode and ramped up to the
speed called for by the speed reference signal via a two or three wire start/stop signal through the digital input
signal.

The VFD shall accept a 4-20 mA Analog signal, a 0-10 VDC Analog signal, or a 0-5 VDC analog signal. The
VFD control system, when in the "AUTOMATIC" mode, shall energize the motor when the process variable
reaches the "START" setting. The motor shall be started in a controlled mode and ramped up to the speed
called for by the input signal.

On decreasing demand a speed reference or a stop command, the VFD will ramp the motor speed down under a
controlled mode. The speed shall be infinitely varied between minimum speed and full rated speed either in
direct proportion or inverse proportion to the signal from the input signal in order to precisely match the
application to the load. With nominal input power voltage and constant load, linearity and repeatability
accuracy of the three-phase outputs shall be within one percent of the input signal.

The VFD shall transmit 4-20 mA DC signals representing the actual operating percent speed and percent load
conditions to the remote DDC panel. Both outputs shall be calibrated for a span of 0-100%.

**Manual Control:** The VFD shall be able to be operated in a manual mode that is independent of any remote
input signal or started manually and controlled from a remote source. In manual/local mode, the speed shall be
capable of being varied from 0-100% speed. This will be done from a control setting on the front panel and/or
remote panel as indicated on the drawings.

**Output Power:** Output frequency shall not vary with any input frequency variations, with +10% or -15% input
temperature changes, or with temperature changes within ambient specification.

The VFD shall be inherently "soft starting" such that the motor will start at zero frequency and shall linearly
ramp up to the set point frequency. Inrush current to the motor during starting, through the inverter, shall not
exceed 115% of motor rated current. The VFD shall have built-in overload protection on each phase to the
motor for operation from both the inverter drive unit and starter.

The output shall maintain a constant RMS volt per cycle within 3% of an output frequency covering a range of
3 to 60 Hz. Voltage in the three phases of the output shall be balanced within 1%. Equipment size and power
output should be sufficient for the motor to which it is connected.

Variable Frequency Drive unit shall be furnished with rating not less than the motor nameplate rated full load
running current.
Current Rating: 100% continuous, 110% for one (1) minute.

Provide controller with over-voltage clamp preventing damage by regenerated energy from high inertia loads or unstable motors.

The VFD shall include the following adjustable functions:

- Acceleration time adjustable from 1 to 50 seconds.
- Deceleration time adjustable from 1 to 50 seconds. Deceleration time adjustment shall be separate and independent from the Acceleration time adjustment.
- Minimum motor speed adjustable from 0% to 80% of maximum motor RPM.
- Maximum motor speed adjustable from 80% to 100% of maximum motor RPM.
- Output frequency range adjustable from 3 to 60 Hz.
- Motor current limit adjustable from 30% to full rated motor current.
- Torque limit
- Voltage boost
- Overload trip setting
- Time delay on auto-restart features
- Speed reference adjustable from 0 to 100%
- Remote speed reference span and offset values

Operator's Control Panel

- Power on indicating light
- VFD running indicating light
- VFD fault indicating light
- Motor over temperature light
- Start push button
- Stop push button
- Digital indicator with linear calibration in percent of motor rated RPM. The digital speed display shall not require the use of a tachometer generator.
- Digital indicator calibrated for percent of motor rated load current in amps. The digital indicator may be the same as used for the speed indicator, but a selector switch must then be provided.
- Hand-Off-Auto selector switch
All lights, pushbuttons, switches, disconnects, and indicators mounted on the VFD shall be labeled.

Diagnostics: First fault indication of the drive protection functions along with the ability to store at least 5 successive faults in order of occurrence shall be provided. The following faults shall be displayed on the alphanumeric display of the operator control panel in an English language format:

1. Instantaneous overcurrent trip
2. Under voltage trip
3. Over voltage trip
4. Ground fault trip
5. Input and/or output phase loss
6. VFD over temperature
7. Motor over temperature
8. Semiconductor fault
9. Input and/or output phase-to-phase fault
10. Overload - stall prevention indications
11. Inverter fault
12. Current limit indication
13. Microprocessor fault

The above conditions shall shut the drive down after the final restart sequence has occurred, sound the audio alarm, and energize the respective diagnostic LED's and control panel lights. The diagnostic LED's and control panel lights shall remain energized until the VFD has been cleared and reset.

Provide the following self-protection equipment and reliability features:

Limit output current to 175-200% of VFD rating.

Current limit shall function automatically, and shall prevent over-current trip due to momentary overload conditions and starting requirements allowing inverter to continue operation.

Under-voltage trip protects inverter due to non-momentary power or phase loss, with shutdown as recommended by the equipment manufacturer.

Under-voltage trip activates automatically when line voltage drops 15% below rated input voltage.

Over-voltage trip protects inverter due to voltage levels in excess of its rating, with shutdown as recommended by the equipment manufacturer.

Over-voltage trip activates automatically when DC bus in controller exceeds 750 VDC.

Over-temperature trip protects inverter from elevated temperatures in excess of its rating.

When over-temperature trip point is reached in any section of the enclosure or in any section of the electronics in the VFD unit, an over-temperature light shall be continuously illuminated.

Ground fault trip protects the unit from output line-to-line and line-to-ground short circuits

The VFD shall have an instantaneous electronic trip circuit to protect the VFD.
Automatic Reset/Restart

When trip condition results from, under-voltage, over-voltage or Drive over-temperature, it automatically resets and inverter automatically restarts upon removal or correction of causative condition.

For safety and equipment protection, limit number of reset/restart attempts for over-current to three.

When after three (3) attempts reset/restart is not successful, inverter shuts down safely, requiring manual restart. The drive shall close a contact for remote indication that the fault reset circuit has not been able to restart the drive.

When within three (3) attempts successful reset/restart occurs, auto reset/restart circuit reset attempts is reset to zero.

In event of sustained power loss, the shutdown and restart attempts shall be controlled safely without component failure; on return of power, the VFD automatically returns to normal operation.

In event of momentary power loss, the shutdown and restart attempts shall be controlled safely without component failure; on return of power, the VFD automatically returns to normal operation.

The variable frequency drive shall be capable of starting into a spinning load with complete protection, and subsequently ramp the motor up to the set speed. The VFD shall be protected from being restarted into a motor coasting in either the forward or reverse direction to protect the components of the VFD.

Short-Circuit Protection: In the event of phase-to-phase or phase-to-ground short circuits, unit components shall be protected from failure by fast acting, current limiting fuses rated to interrupt 200,000 amps.

Power Interruption: When input or output power contactor is opened while control is activated, control is not damaged.

Stand-Alone Operation: Provides for start-up, trouble-shooting, and operation of control without motor or any other equipment connected to inverter output.

Solid-state transient protection integral to the VFD shall be provided to a minimum of 5,000 volts without failure. Surge withstand capability of power input, power output and control signal inputs and outputs shall meet or exceed American National Standards Institutes (ANSI) standard C62.41 - 1992. Failure is to be defined as loss of components in the VFD including power semi-conductors and logic components.

Quality Assurance, Burn-In: All power semiconductors, chips, subassemblies, and printed circuit boards shall be tested at the factory for conformance with manufacturer's specifications. The completed drive shall be functionally tested with a motor and at all frequencies for a minimum period of 10 hours at the factory before shipment to assure proper operation of the drive.

Accessories: Door mounted accessibility interlocked disconnect switch to prevent opening the door while the disconnect switch is in the on position. An override feature shall be provided for servicing Electronic Overload Relay.

Auxiliary control transformer with fused primary and secondary sized for capacity of all controls and accessory devices associated with operation of the drive.

Factory installed branch circuit protection fuses.

Floor stand where required by physical size of unit.
PART 3. - EXECUTION

General: Install variable frequency drives in accordance with manufacturer's instructions.

Installation shall include connection of input power circuitry, circuitry and connections between the drive and the motor, connections of the speed reference signal to the VFD.

All such installation procedures shall conform to Division 26 electrical requirements.

Training: The VFD supplier shall provide complete on-site training for the Owner's operating, maintenance and engineering personnel. All costs for this training shall be included in the proposal cost.

The trainer shall be factory certified by the VFD manufacturer.

This training shall be a minimum of two (2) hours. Include in the training a complete description on Theory of Operation, Operating Procedures, Functional and Operating Characteristics of Specific Logic Boards, Troubleshooting, Repair and Preventative Maintenance.

A complete operations and maintenance manual shall be furnished with the unit.

END OF SECTION
SECTION 265113

INTERIOR LUMINAIRES, LAMPS, AND BALLASTS

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PART 1. - GENERAL

1.1. RELATED DOCUMENTS

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

Section 260500, General Electrical Provisions

1.2 REGULATORY AGENCIES

Conform to the applicable requirements of the following agencies’ most current edition of regulations and standards, unless otherwise stated:

1. American National Standards Institute (ANSI)
2. Illuminating Engineering Society of North America (IESNA)
3. Federal Communications Commission (FCC)
4. Environmental Protection Agency Green Lights Program

1.3 SUBMITTALS

Product Data: For each type of lighting fixture, arranged in order of fixture designation, include data on features, accessories, finishes, and the following – any submittal missing information shall be rejected:

1. Physical description of lighting fixture including dimensions and housing material.
2. Emergency lighting units including battery, charger, indicating lights, and testing device.
4. Life, mean output lumens, color temperature, color rendering index, and mercury content.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for drivers and accessories identical to those indicated for the lighting fixture as applied in this Project.
   a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Additional LED submittal requirements – provide the following information in addition to the other required preceding information for all LED luminaires:
   a. Rated input power (in W)
   b. Rated luminous flux (in lm)
   c. LED luminaire efficacy (in lm/W)
   d. Luminous intensity distribution
   e. Photometric code
      i. Correlated Color Temperature (CCT in K)
      ii. Rated Color Rendering Index (CRI)
      iii. Rated chromaticity co-ordinate values (initial and maintained)
      iv. Maintained luminous flux
   f. Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)
   g. Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire
   h. Ambient temperature (ta) for a luminaire
   i. Power Factor
   j. Intensity Distribution
   k. Drive Current

Installation Instructions: Include one set for each fixture type that includes installation instructions for all parts and accessories.

Warranty: Provide complete manufacturer’s warranty information on all products provided.

Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

Source Limitations: Limit the use of multiple LED and driver manufacturers unless equipment specified requires multiple manufacturers. LED fixtures shall be procured through a single order from the manufacturer to provide product consistency.

NEMA Compliance: Comply with applicable requirements of NEMA LE Standards pertaining to lighting equipment.

UL Compliance: Normal and Emergency luminaries shall comply with requirements for UL 1598 Standard for Luminaires and Emergency luminaries shall comply with UL 924 Standard for Emergency Lighting and Power Equipment. Provide listed and labeled luminaires as indicated by project documents.

FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.5 **COORDINATION**

Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire suppression system, and partition assemblies.

1.6 **EXTRA MATERIALS**

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

2. LED Drivers: 1 for every 10 of each type and rating installed. Furnish at least one of each type.

1.7 **WARRANTY**

Warranty for LED Luminaries: Utilize manufacturer's standard form in which manufacturer of LED Luminaire agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period for LED Luminaries: 5 years from date of Substantial Completion. Full warranty shall apply to full term for all parts and accessories, including remote drivers and controllers.

**PART 2. - PRODUCTS**

2.1. **LUMINAIRES**

Manufacturers subject to compliance with requirements, provide products of one of the manufacturers listed in the lighting fixture schedule, drawings, and requirements listed within this specification (for each type of interior and building mounted lighting fixture). Substitutions shall meet or exceed the performance specifications outlined in the lighting fixture schedule and drawings under each specified fixture designation and manufacturer. Follow protocol as directed in the “Substitution Procedures” specification for all manufacturers not listed in the lighting fixture schedule.

For lighting fixtures and components, comply with the following:

1. Recessed fixtures shall comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

2. Metal parts shall be free of burrs and sharp corners and edges.

3. Doors, frames, and other internal access shall be smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools, unless otherwise indicated and in classified locations. Designed to prevent doors frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

4. Factory applied labels in compliance with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

Provide luminaires, of sizes, types and ratings indicated. Ship the fixtures factory-assembled, with parts required for a complete installation. Lamps shall be purchased separately and installed in field.
2.2. **EMERGENCY LIGHTING FIXTURES, BALLASTS, AND CONTROLLERS**

**Exit Signs:**
Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

Internally Lighted Signs shall comply with the following:

1. Lamps: LEDs, 70,000 hours minimum rated lamp life.
2. Input Watts: 5 watts/face

Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3. **LED LUMINAIREs**

Must comply with UL 8750.

Minimum CRI 85, color temperature range within 3 MacAdam Ellipses of specified color temperature indicated on the lighting fixture schedule, average life of 50,000 hours or greater at 70% lumen maintenance. Luminaire shall be tested in accordance with IESNA LM-80 and TM-21 for lumen output, and IESNA LM-79 for lumen rating of fixture. Fixture shall meet LED lamp and driver manufacturer’s recommendations for thermal dissipation, operating temperature ranges, operating voltage and current, and peak pulse forward current. LED engines must be tested according to IESNA LM-82.

Fixture must have a minimum efficiency of 85%. Drivers must have a total harmonic distortion of less than 10% and comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards. Drives must be RoHS compliant.

Luminaires shall be as specified for each type in luminaire schedule

Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

Luminaires shall start and operate in 0°C to +40°C ambient.

Electrically test fully assembled luminaires before shipment from factory.

Luminaires shall be designed for ease of component replacement and end-of-life disassembly.
Transmissive optical components shall be applied in accordance with OEM design guidelines to ensure suitability for the thermal/mechanical/chemical environment.

Electrical immunity:
1. Manufacturer shall indicate on submittal form whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

Electromagnetic interference:
1. Shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.

Electrical safety testing:
1. Where applicable, luminaire shall be listed for wet locations by an OSHA NRTL.
2. Luminaires shall have locality-appropriate governing mark and certification.

Painted or finished luminaire components exposed to the environment
1. Shall exceed a rating of six per ASTM D1654 after 1000hrs of testing per ASTM B117.
2. The coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.

Thermal management:
1. Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
2. Liquids or other moving parts within the luminaire shall be clearly indicated in submittals, shall be consistent with product testing, and shall be subject to review by Owner.

Correlated Color Temperature (CCT) as indicated on luminaire schedule
1. If nominal CCT specified in luminaire schedule is listed in Table 1 below, the measured CCT and Duv ranges are given. Note that if 4000K nominal is specified but 4100K nominal is deemed acceptable, it would be appropriate to specify in the luminaire schedule either a range of nominal CCTs or tolerances for the nominal CCT specified.

<table>
<thead>
<tr>
<th>Manufacturer-Rated Nominal CCT (K)</th>
<th>Allowable Chromaticity Values</th>
<th>Measured CCT (K)</th>
<th>Measured Duv</th>
</tr>
</thead>
<tbody>
<tr>
<td>3500</td>
<td>3400 to 3600</td>
<td>-0.006 to 0.006</td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>3880 to 4130</td>
<td>-0.005 to 0.007</td>
<td></td>
</tr>
</tbody>
</table>

The following shall be in accordance with corresponding sections of ANSI and NEMA standards.

1. Wiring and grounding
2. All internal components shall be assembled and pre-wired using modular electrical connections.
3. Mounting provisions
4. Terminal blocks for incoming AC lines
5. Latching and hinging
6. Ingress protection
LED Driver

Rated case temperature shall be suitable for operation in the luminaire operating in the ambient temperatures indicated. Shall accept the voltage or voltage range indicated at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.

1. Shall have a minimum Power Factor (PF) of 0.90 at full input power and across specified voltage range.
2. Control signal interface
   a. Luminaires shall accept a 0-10V control signal for dimming. Continuous dimming from 100 percent to 10 percent relative light output.
3. Ability to operate with installed or specified building control system
4. Lights automatically return to the setting prior to power interruption.
5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
6. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements
7. In applications with fixture types, all drivers track together with even illumination.
8. Drivers to track evenly across:
   a. Multiple fixtures.
   b. All light levels.

2.8. LIGHTING FIXTURE SUPPORT COMPONENTS

One or more of the following support methods is acceptable based on the type of installation required.

Comply with "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
PART 3. - EXECUTION

3.1. INSTALLATION

Install interior luminaires at locations and heights as indicated, in accordance with fixture manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation”, NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.

Using architectural reflected ceiling plan dimensions and details, locate luminaries precisely.

Where heights are not indicated within the project documents, confirm desired mounting height with engineer.

Do not install reflector cones and visible trim of luminaires until completion of plastering, ceiling tile work, painting, and general cleanup.

Installation of reflector cones and visible trim of luminaires shall be carefully coordinated with ceiling openings to prevent light leaks at the ceiling plane.

Handle cones and trim carefully to avoid scratching or finger printing. Luminaires shall be completely clean at time of acceptance by Owner.

Temporary Lighting: if it is necessary, and approved by Architect and Engineer, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary.

When construction is sufficiently complete, remove the temporary luminaries, disassemble, clean thoroughly, install new lamps, and reinstall.

Install flush mounted fixtures to eliminate light leakage between fixture frame and finished surface.

Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

Fasten fixtures securely to indicated structural supports; and ensure that pendant fixtures are plumb, level, and square with ceilings and walls unless directed otherwise.

Provide stem hanger with ball aligners and provisions for minimum 1” vertical adjustment.

Mount a continuous row of fixtures with an additional stem hanger, greater than number of fixtures in the row.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors.

Support surface mounted fixtures greater than two (2) feet in length at a point in addition to the outlet box fixture stud.
Lay-in Ceiling Lighting Fixtures Supports:

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.


3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

Install lamps in each luminaire, burn in lamps per manufacturer’s recommendations, and replace any failed lamps.

Wear special gloves, as approved by the fixture manufacturer, to preclude smudging or damaging the reflector surface when installing fixtures and lamps in fixtures with specular reflector material. Install removable reflectors and louvers in place after the project is complete and dust-free or provide with protective cover over louvers, UL listed for temporary lighting. Upon completion of work, remove cover with special gloves indicated above.

Where fixtures are wall-mounted and protrude from the wall surface, provide additional structural support within the wall framing to accommodate the extra moment force created by the fixture.

Accessibility: Install equipment such as junction and pull boxes, fixture housings, divers, switches and controls, and other apparatus that requires occasional maintenance to be accessible and appropriate for mounting and ceiling conditions.

3.2. ADJUSTING AND CLEANING

Clean interior luminaires, of dirt and construction debris, upon completion of installation. Clean fingerprints and smudges from lenses.

Protect installed fixtures from damage during remainder of construction period.

Adjust amiable fixtures, including emergency lighting units, per engineer and architects recommendations and the authority having jurisdiction.

3.3. GROUNDING

Provide equipment-grounding connections for interior luminaires as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounds.
3.4. **TESTING**

Upon completion of installation of interior luminaires, and after building circuitry has been energized, apply electrical energy to test capability and compliance with requirements.

Where possible, correct malfunctioning units at site, then retest capability and compliance with requirements; otherwise, remove and replace with new units, and proceed with retesting.

After emergency luminaries have been installed and building circuits have been energized with normal power source, apply and interrupt electrical energy to test proper operation.

Remove and replace malfunctioning fixtures with new fixtures and proceed with retesting. Prior to tests, install new lamps in emergency luminaires. After testing replace malfunction lamps.

Check for visual uniformity of illumination. Check for excessively noisy drivers.

Demonstrate operation of luminaires with the Owner and the Engineer. Re-aim luminaires as directed by Architect and Engineer.

**END OF SECTION**
### PART 1. - GENERAL

#### 1.1. QUALITY ASSURANCE

**Contractor’s Qualifications:** Firm who is regularly engaged in the installation of fire detection, alarm, and control with work similar to that required for this project for not less than five (5) years.

**Manufacturer’s Qualifications:** Firm who is regularly engaged in the manufacture of multiplexed audio/fire detection, alarm, and control systems and who have a factory trained and authorized service organization within 100 miles.

The Owner reserves the right to reject any or all equipment submitted by any manufacturer.

The manufacturer shall have on staff a minimum of one (1) National Institute for Certification of Engineering Technologies (NICET) certified in Level 3 Fire Alarm Systems that shall oversee and be responsible for the project and sign off on all drawings submitted by the equipment supplier.
UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to fire alarm systems and provide products and components which are UL listed and labeled.

- U.L. 268 Smoke Detectors.
- U.L. 1480 Fire Alarm Signaling Devices.
- U.L. 1076 Security Signaling System.

NFPA Compliance: Comply with applicable requirements of NFPA standards pertaining to fire alarm systems:

- NFPA 70, 72, 90A, 90B and 101.

FM Compliance: Provide fire alarm systems and accessories which are FM approved.

1.2. SUBMITTALS

Product data for each type of product specified: Indicate the type, size, rating, style, catalog number, manufacturers' names, photos, and/or catalog data sheets for all items to ensure compliance with these specifications.

This equipment shall be subject to approval and no equipment shall be ordered without approval. Equipment devices are shown on the Contract Documents.

Calculations to support size of standby batteries submitted.

Printed product data, catalogue cuts, and description of any special installation procedures.

Submit shop drawings indicating location and routing of all cabling and equipment. Drawings shall be updated and submitted at the completion of the project as "Record Drawings." Shop drawings detailing fire alarm system including, but not limited to the following:

- Complete one-line riser diagram showing all equipment and size, type and number of all conductors.
- Floor plans indicating location and routing of all cabling and equipment.
- Large scale drawing of a typical multiplexed field panel.
- Wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

Maintenance data for materials and products for inclusion in Operating and Maintenance Manual. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

1.3. RELATED WORK

Coordinate work in this Section with all related trades.

1.4. WARRANTY

The manufacturer shall warrant the Fire Alarm System components as follows:

Warranty all control equipment, analog sensors and addressable I/O modules for one (1) year. All other materials, including peripherals, installation, and workmanship, should be warranted for one (1) year from date of substantial completion unless otherwise specified.
Upon completion of the installation of the fire alarm system equipment, the contractor shall provide the Owner a signed statement, substantially as follows: “The undersigned, having engaged as the contractor on the UTA VIVARIUM PROJECT, confirms that the fire alarm system equipment installed in agreement with the wiring diagrams and written instructions and directions provided by the Manufacturer.”

PART 2. - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

Acceptable Manufacturers: Subject to compliance with requirements, provide fire system by same manufacturer

2.2. FIRE ALARM AND DETECTION SYSTEMS

General: Provide complete fire alarm system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated.

At the time of bid, all exceptions taken to these Specifications, all variances from these Specifications and all substitutions of operating capabilities or equipment called for in these Specifications shall be listed in writing and forwarded to the Engineer. Any such exception, variances or substitutions which were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.

Scope: Provide complete and fully operational addressable fire detection, alarm and control system in complete compliance with all applicable portions of the entire Division 26000 Specifications. The fire detection, alarm and control system shall be compatible with all other Division 26000 systems.

The fire detection, alarm and control system shall detect fire conditions, alarm the building occupants of a fire condition, control the necessary systems to suppress fire and smoke and shall summon the firefighting teams, automatically without the need for human intervention/human action.

The system shall have the capability of being activated into both alarm and supervisory modes of operation from both manual and automatic devices.

The fire alarm and protective system shall be a single line computerized multiplex system utilizing distributed processing techniques, extended from the existing building fire alarm system. Intelligent panels shall be used to integrate peripheral devices such as manual stations, tamper switches, etc., smoke detectors, heat detectors, and waterflow switches into the multiplex network.

Communications between fire alarm panels shall be accomplished through digital transmission techniques.

The system shall have full addressable sensing techniques and will be able to identify the exact location of every sensor and monitored device in the system.

They shall provide changes in sensitivity levels within the UL approved sensor's range and automatic maintenance reports when a sensor drifts to within 50% of assigned alarm levels.

The operator shall be able to determine what any device's location, analog level and sensitivity setting are at any time.

All new components shall be connected to the existing Fire Alarm Control Panel, provide additional battery and notification appliance circuit panels as necessary.
The system shall operate as a low voltage, device annunciated system and shall include:

- Integration with the existing Main fire alarm control panel (FACP) to permit overall system monitoring, system testing, display, English printout of alarm activity, and fire fighter controls to override the automatic actions. FACP shall monitor remote intelligent panels, initiating devices, annunciate the alarmed device and its location, annunciate system trouble, capture elevators, and trip the municipal connection. FACP shall be located as indicated on the drawings.

Provide the following subsystems as needed:

- Remote intelligent panels to integrate peripheral devices such as manual stations, tamper switches, etc., smoke detectors, heat detectors and workflow switches into the multiplex network.

- Fire alarm initiating devices shall each be individually identifiable and shall respond with their condition. Control relays shall be individually commandable by the system to respond automatically in the event of an alarm of related sensors to other devices. Manual control of such relays by the operator shall also be individually commandable.

All equipment, with the exception of the FACP, shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on Contract Documents shall be the best suited for the intended use and shall be provided by a single manufacturer or if provided by different manufacturers, recognized as compatible by both manufacturers.

2.3. SYSTEM WIRING AND SUPERVISION

Circuiting Guidelines - Addressable analog circuit zoning shall be as follows:

- **Manual Fire Alarm Stations**: Provide one (1) alarm initiating point for each.
- **Area Smoke Detectors**: Provide one (1) alarm initiating point for each room or area as per the plans.
- **Duct Smoke Detectors at HVAC Units**: Provide one (1) alarm initiating point for each HVAC unit supply and each return duct detector(s) where shown.
- Each of the following types of alarm sounding, communication or alarm indicating devices shall be circuitized as shown on the drawings, but shall typically be as follows:

  - **ADA Strobe Lights/Horns**: Provide circuiting and zoning as shown on the contract documents.

The fire alarm and protective system wiring shall be electrically supervised to automatically detect and report trouble conditions to the FACP.

Any opens, ground, or disarrangement of system wiring and shorts across alarm horn or alarm lamp wiring shall automatically:

- Sound an audible signal at the FACP. The audible signal shall be capable of being silenced during the trouble condition.
- Illuminate a general trouble LED, at the FACP. The LED shall remain lit, until the trouble condition is cleared.
- Visually annunciate, via an individual LED, the individual circuit in trouble, at the FACP. The LED shall remain lit, until the trouble condition is cleared.
- Grounds shall annunciate as a system trouble.
- On the FACP, display the information for the circuit in trouble, as previously described.
2.4. FIRE ALARM AND PROTECTIVE SYSTEM SEQUENCE OF OPERATION

Operation of a fire alarm manual station, space smoke detector, elevator smoke detector, heat detector, sprinkler flow switch, or any automatic fire alarm-initiating device shall automatically:

- Sound all audible notification appliances throughout the building. The notification appliance devices shall sound continuously (unless manually silenced or as otherwise instructed by the Fire Marshall) until the alarm-initiating device is restored to normal and the system reset. The silencing of an alarm condition shall not prevent the resounding of alarm devices if a subsequent condition occurs.
- Activate all visual appliances throughout the building. Silencing the alarm devices (audible circuits) shall not automatically turn off flashing visual appliances.
- Operate control relays to recall all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, recall the elevators to that floor or other level as directed by the Fire Marshall.
- Operate control relay to initiate the transmission of an alarm condition to a central station agency (existing site alarm system). Selection of a central station agency, its equipment, its fees, and fees for leased telephone lines are the responsibility of the owner or his representative.
- Operate control relays to release electrically held open doors.
- Operate control relays to de-energize secured exit/entry doors.
- Sound an audible alarm signal and illuminate a general alarm LED at the main building. The audible signal shall be capable of being silenced during the alarm condition. The LED shall remain lit, until the alarm condition is reset.
- Display on the FACP the time, date and alarm circuit number followed by a complete emergency description for that alarm circuit. Each alarm circuit shall display its own emergency message up to 40 characters and spaces. All restorations to normal shall likewise be displayed. The FACP shall display messages according to their priority and shall hold any message on the display until such time as the operator acknowledges the message. No message shall be lost or scroll off the display due to operator delay. Time of day and the number of messages waiting to be acknowledged, number of abnormal points, number of disabled points shall be displayed at all times on the upper line of the FACP.
- Provide contacts for the building automation system (BAS) from the FACP for general alarm and trouble.

Activation of duct smoke detectors shall:

- Shut down air handling unit (AHU) through relay contact to AHU starter. Duct smoke detector is the only device that shall automatically shutdown an AHU.
- Sound all fire audible notification appliances throughout the building. The notification appliance devices shall sound continuously (unless manually silenced or as otherwise instructed by the Fire Marshall) until the alarm initiating device is restored to normal and the system reset. The silencing of an alarm condition shall not prevent the resounding of alarm devices if a subsequent condition occurs.
- Activate all fire visual appliances throughout the building. Silencing the alarm devices (audible circuits) shall not automatically turn off flashing visual appliances.
- Operate fire control relays to recall all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, recall the elevators to that floor or other level as directed by the Fire Marshall.
- Operate fire control relay to initiate the transmission of an alarm condition to a central station agency (existing site alarm system located in existing main building). Selection of a central station agency, its equipment, its fees and fees for leased telephone lines are the responsibility of the owner or his representative.
- Operate control relays to release electrically held open doors.
- Operate control relays to de-energize secured exit/entry doors.
- Sound an audible alarm signal and illuminate a general alarm LED at the FACP or central monitoring station. The audible signal shall be capable of being silenced during the alarm condition. The LED shall remain lit, until the alarm condition is reset.

- Display on the FACP the time, date and alarm circuit number followed by a complete emergency description for that alarm circuit. Each alarm circuit shall display its own emergency message up to 40 characters and spaces. All restorations to normal shall likewise be displayed. The FACP shall display messages according to their priority and shall hold any message on the display until such time as the operator acknowledges the message. No message shall be lost or scroll off the display due to operator delay. Time of day and the number of messages waiting to be acknowledged, number of abnormal points, number of disabled points shall be displayed at all times on the upper line of the FACP.

- Provide contacts for the building automation system (BAS) from the FACP for general alarm and trouble.

Actuation of a sprinkler valve tamper switch shall automatically:

- Sound an fire audible signal at the FACP. The audible signal shall be capable of being silenced during the trouble condition. The silencing of a trouble condition in any zone shall not prevent the resounding of audible signal should a subsequent trouble condition occur.

- Illuminate a general trouble LED, at the FACP. The LED shall remain lit, until the trouble condition is cleared.

- Visually annunciate, via an individual LED, the monitor circuit which has been actuated at the FACP. The LED shall remain lit, until the trouble condition is cleared.

- On the FACP printer, print a record for the monitor circuit point, as previously described.

- On the FACP, display the information for the monitor circuit point, as previously described.

- Provide a contact for general alarm and trouble as described previously.

2.5. **INTELLIGENT SYSTEM DEVICES**

Provide intelligent analog smoke and thermal sensors. The address shall be dialed in at the sensor by the installer using the rotary switches located in the sensor head or module. All intelligent analog sensors shall be interchangeable, ceiling mountable and shall use common twist-lock bases. All sensors shall provide dual alarm LEDs. Both LEDs shall flash under normal operating and communication conditions and both LEDs shall illuminate at steady state when the sensor's sensitivity level (analog value) exceeds the predetermined limit and commands from the FACP place the sensor into the alarm state. All sensors shall include a test means, whereby the sensor's actual analog value and the number of times the sensor has entered the alarm verification mode shall be displayed on the FACP LCD display, or by locally activating the sensor's internal magnetic switch. Activating the sensor remotely by a FACP command without the control panel being in other than the test mode shall not be allowed. When the sensors reach a predetermined sensitivity the FACP shall automatically display a maintenance alert message. All single I/O modules shall contain an alarm LED that shall flash during normal operation and communication and shall go to a steady state when commanded by the control panel that an alarm or supervisory value has been detected.

2.5.1. **Intelligent Ionization Sensor**

The Intelligent Ionization Sensor shall connect with two (2) wires to one of the FACP loops. The sensor shall be easy to install into a twist-lock base. The sensor shall incorporate built-in type identification so the system can identify the type of sensor. The sensor shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, smoke, temperature, humidity, etc.). The sensor shall use the ionization principle to measure products of combustion. The sensor shall provide advanced indication of the analog value of the products of combustion to the FACP that maintenance is required, thus reducing the maintenance required to inspect routinely all sensors, in order to ensure normal operation. The sensor sensitivity shall be adjustable per device (within UL limits).
2.5.2. **Intelligent Photoelectric Sensor**

The Intelligent Photoelectric Sensor shall connect with two (2) wires to one of the FACP loops. The sensor shall be easy to install into a twist-lock base. The sensor shall incorporate built-in type identification so the system can identify the type of sensor. The sensor shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, smoke, temperature, humidity, etc.). The sensor shall use the photoelectric principle to measure smoke density and shall on command from the FACP send data to the panel representing the analog value of the smoke density. The sensor shall provide advanced indication of the analog value of the level of smoke density to the FACP that maintenance is required, reducing the maintenance required to inspect routinely all sensors in order to ensure normal operation. The sensor sensitivity shall be adjustable by device.

2.5.3. **Intelligent Duct Detector**

The Intelligent Duct Detector shall be 24 VDC system powered and shall connect with two (2) wires to one of the FACP loops. This detector shall be analog photoelectric type with Form-C relay output contacts for local control purposes. Each duct detector also shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code which the FACP shall use to identify the type of device. For special application or changes in occupancy, a field sensitivity adjustment shall be provided. Detector shall be listed for U.L. Standard 268. Each detector shall be supplied with duct mount housing tubes, sized according to duct width. Where shown, supply remote alarm pilot lamp for mounting at hung ceiling.

2.5.4. **Intelligent Fire Alarm Manual Pull Stations**

The Intelligent Manual Station shall connect with two (2) wires to one of the FACP loops. The Manual Station shall, on command from the FACP, send data to the panel representing the state of the manual switch. The Manual Station shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code that the FACP shall use to identify the type of device.

Manual stations shall be single action of the non-coded type with terminals and contain an internal toggle switch. The red manual station shall be constructed of rugged aluminum with a key reset switch for positive resetting action. The manual station shall flush mount to a standard single gang switch box or on an optional red surface mount box where required by wall materials. The manual station shall have a red finish with white lettering letting reading “FIRE”.

All Cleanroom installations shall come with NEMA 4X wash-down cover model STI-1100NR or approved equal.

2.5.5. **Intelligent Monitor Module**

An Intelligent Monitor Module shall be used to connect a supervised conventional initiating device or zone of supervised conventional initiating devices (water flow switches, tamper switches) to one of the two-wire intelligent analog loops. The module shall mount in a four-inch square, 2 1/8-inch deep electrical box and shall be capable of Class “A” or “B” supervised wiring to the initiating device. In order to maintain proper supervision there shall be no T-taps allowed on Class "A" lines. The Monitor Module shall provide address-setting means using rotary decimal switches and also store an internal identifying code that the FACP shall use to identify the type of device. The Monitor Module shall contain an integral LED that flashes each time the monitor module is polled.

2.5.6. **Intelligent Control Module**

An Intelligent Control Module shall be used to connect and supervise a conventional indicating device or zone of indicating devices that require an external power supply, such as horns and strobes, to one of the FACP (2) wire intelligent analog loops (Class "A" or "B"). The Control Module shall be capable of operating as a relay (dry contact form C), to control Door Holders, Air Handling units, etc.
The module shall mount in a 4-inch square, 2 1/8-inch deep electrical box and shall be capable of Class "A" or "B" supervised wiring to the indicating or control device. The Control Module shall contain an integral LED that shall flash each time the module is polled. The Control Module shall provide address setting means using rotary decimal switches and also store an internal identifying code which the control panel shall use to identify the type of device.

2.5.7. **Isolation Module**

The Isolation Module shall be an automatic switch, which will open when the intelligent loop voltage drops below 4 volts. The Isolator Module shall be placed between groups of sensors/intelligent modules on each loop in order to protect the intelligent loop if a short (less than 4 volts) should occur. If a short occurs between any two (2) isolators, then both isolators switch to an open circuit condition and isolate the group of sensors/modules between them. The remaining devices on the intelligent loop shall continue to operate and communicate normally. The number of devices between isolators shall be 25 or less. The Isolator shall be designed to mount in a 4-inch square, 2 1/8-inch electrical box.

2.5.8. **Fire Alarm Horn/Strobes (Flush Wall Mount)**

Combination horn/strobes shall be wired separately to different intelligent control modules. Provide manufacturer's standard construction fire alarm horn/strobe units meeting ADA requirements with following features:

- Non-coded.
- Flush mounted.
- Red Housing.
- Single projection.
- Clear lens, plain or lettered red "FIRE".
- 24-volt DC Xenon flasher, adjustable candela settings.
- System Sensor SpectrAlert Advance Series Indoor Selectable-Output Strobes and Horn Strobes for Wall Applications
- Outdoor Wet or Damp Locations Only: Provide make and model to match indoor units except with weatherproof listing. Provide make and model suitable for intended installation.
- Cleanroom Applications Only:
  - Strobe Device Covers: Model STI-1221E or approved equal
  - Combination Horn Strobe Covers: Model STI-1210E or approved equal

2.5.9. **Fire Alarm Horn/Strobes (Flush Ceiling Mount)**

Combination horn/strobes shall be wired separately to different intelligent control modules. Provide manufacturer's standard construction fire alarm horn/strobe units meeting ADA requirements with following features:

- Non-coded.
- Flush mounted.
- Red Housing.
- Single projection.
- Clear lens, plain or lettered red "FIRE".
- 24-volt DC Xenon flasher, adjustable candela settings.
- System Sensor SpectrAlert Advance Series Indoor Selectable-Output Strobes and Horn Strobes for Ceiling Applications
- Cleanroom Applications Only:
  - Strobe Device Covers: Model STI-1221E or approved equal
  - Combination Horn Strobe Covers: Model STI-1210E or approved equal
2.5.10. **Digital Communicator**

Provide manufacturer’s standard Digital Alarm Communicator Transmitter (DACT). DACT shall be dual line, four-channel type and shall transmit Alarm, Trouble, and Supervisory signals.

Contractor shall insure that DACT is compatible with owner’s contracted alarm monitoring service. Contractor shall connect DACT to owner’s telephone line and program and fully test unit to verify successful transmission of required signals.

**PART 3. - EXECUTION**

3.1. **INSTALLATION OF FIRE ALARM SYSTEMS**

Install fire alarm system as indicated, in accordance with equipment manufacturer’s written instructions and complying with applicable portions of NEC and NECA’s "Standard of Installation."

**Wiring:** All wiring for the System shall be in accordance with Articles 760, 725, and 800 of the National Electric Code and local electrical codes.

Provide complete wiring and conduit between all equipment. Unless specified otherwise herein, all initiating circuit wire shall be minimum # 18 Type FPL twisted pair (solid) and indicating circuit wire shall be minimum # 14 Type FPL twisted pair (solid) in separate raceway, maximum 40% fill, minimum ¾” conduit or approved fire alarm cable as recommended by manufacturer. If cable is used, conduits of proper size shall be installed from all equipment and devices into accessible space; all devices shall be mounted upon listed boxes. Wiring splices and transposing or changing colors will not be permitted. All junction boxes shall be painted red and labeled as "Fire Alarm System", with decal or approved markings.

Where there are a number of power requiring devices such as smoke detectors, fan relays, door holders and smoke damper operators installed in a circuit, group in numbers so power required does not exceed 80% of manufacturer's power supply rating. Provide extra wiring, or extra power supplies required to fulfill that requirement. In addition, provide extra or larger size wiring to alleviate voltage drops which makes device operate beyond voltage limits for which it was designed. Determine above with manufacturer's representative while equipment is being installed. All 24 VDC power utilized for devices shall be monitored utilizing end-of-line relays on monitor module.

All Equipment shall be held firmly in place. Fastening and supports shall be adequate to support the loads with a safety factor of five (5).

Fire control center systems and equipment shall be connected to separate dedicated branch circuits, sized as required for proper service. Circuit shall be labeled as "FIRE ALARM".

Install wires and cable without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.

Sampling tubes shall be factory drilled with the number and size of holes required for duct size. Sampling tubes shorter than 48 inches shall be supported at the remote end by a support mounted on inside of the duct. Tubes longer than 48 inches shall be supported with a “V” bracket or strap hanger. Supports shall not cover any holes in sampling tubes. Remote end of tubes shall not penetrate opposite duct walls.

Detector sensitivity shall be individually adjusted and set by a factory trained technician at installation. All detectors shall be mounted in full accordance with manufacturer's instructions.
Provide silicon calking around all device covers in all cleanroom installations.

3.2. **FIELD QUALITY CONTROL**

**Connection and Supervision:** Make connections to panel under manufacturer's supervision.

**System Test and Approval:** Submit shop drawings for function and operation only, pre-approved by authority having local jurisdiction.

Prior to final acceptance of system, manufacturer of system shall, in presence of Contractor, Owner's Representative and/or Engineer's representative, test each sensing or detection and alarm device.

**Air Duct Velocity:** Shall be checked on each duct detector and the reading included in the test report by the technician.

Submit copy of test results in duplicate after signed by Owner's Representative to Engineer and Owner. Test report shall be submitted indicating proper functioning of system, conformance to the specifications and system left in operating condition. The test shall be performed by factory-trained qualified technicians. Each and every device shall be tested.

Manufacturer shall guarantee all system equipment for a period of one (1) year from date of substantial completion of the facility.

Contractor shall guarantee all raceways and wiring to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.

Upon completion of the installation of fire alarm and protective systems equipment, this contractor shall provide to the Architect/Owner a signed written statement, substantially in form as follows:

"The undersigned, having engaged as the Fire Alarm Contractor on the [NAME OF PROJECT], confirms that the fire alarm and protective system equipment was installed in accordance with the wiring diagrams, instructions, and directions provided."

Submit a proposal for a Fire Alarm System Service Contract for up to five (5) years, renewable annually with cost for each year for Owner's review/acceptance as part of base contract.

3.3. **TRAINING**

Factory technician shall instruct owner's designated personnel for a minimum of four (4) hours in the operation of the system. A fully qualified, trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation shall present training sessions. Instruction shall include, but not be limited to, resetting manual stations, smoke detectors, motion detectors, replacing fuses, and the operation of all system equipment.

The Contractor shall post the name, address and telephone number of the Contractor, all subcontractors and the Fire Alarm Installer and Service Organization on the inside cover of the FACP.

END OF SECTION