Architect's Project No. 214100569

Issued for PERMIT/BID SET
2022.06.21

Detroit Public Schools Community District

OWNER:
Detroit Public Schools Community District

ARCHITECT:
Stantec Architecture Inc.
2338 Coolidge Highway
Berkley, MI 48072
248.336.4700
SECTION 00 01 07 - SEALS PAGE

1.1 CERTIFICATIONS

A. Each of the design firms listed below certify that they have prepared or directly supervised the preparation of their respective Drawings and Specifications, and that each is currently and legally licensed as an Architect or Engineer in Michigan.

B. Each of the design firms below is responsible only for the content of the Drawings and Specifications which were prepared or directly supervised by each design firm, as briefly described below each seal, and does not accept responsibility for the content of any Drawings or Specifications which were not prepared or supervised by each design firm.

Name: Lindsay Woods  
Firm: Stantec  
Design Responsibility: Architectural

Name: Paul Roepnack  
Firm: Stantec  
Design Responsibility: Structural

Name: Casimir Zalewski  
Firm: Stantec  
Design Responsibility: Mechanical

Name: William Chomic  
Firm: Stantec  
Design Responsibility: Electrical

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<td>26 99 99</td>
<td>Electrical Testing</td>
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**DIVISION 22 - COMMUNICATIONS**

None issued
DIVISION 28 - ELECTRONIC SAFETY AND SECURITY


DIVISION 29 - RESERVED

Site and Infrastructure Subgroup

DIVISION 30 - 39

None issued

Process Equipment Subgroup

DIVISION 40 - 49

None issued

END OF DOCUMENT 00 01 10
SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Phased construction.
   4. Work by Owner.
   5. Work under separate contracts.
   6. Purchase contracts.
   7. Owner-furnished products.
   8. Contractor-furnished, Owner-installed products.

1.03 PROJECT INFORMATION

A. Project Identification: Detroit Public Schools Community District.
   1. Project Location: Detroit, MI.

B. Owner: Detroit Public Schools Community District.
   1. Owner's Representative: Machion Jackson.

C. Architect: STANTEC.

D. Construction Manager: Clark | White (a Joint Venture).
   1. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.

1.04 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
   1. Renovations and additions to the following schools and other Work indicated in the Contract Documents.
      b. CMA Ludington.
      c. Fisher Magnet Upper Academy.
      d. Harms Elementary School.
      e. Erma Henderson Upper School.
      f. not used
      g. John R. King Academy.
      h. Keidan Special Education Center.
      i. Mann Elementary School.

B. Type of Contract:
   1. Project will be constructed under a single prime contract.
1.05 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, where applicable.

1.06 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 Construction Manager 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. Conflicts in Contract Documents:
   1. If a conflict is recognized during bidding, the subcontractor shall immediately request clarification from the Architect through the Construction Manager per the RFI procedures. If an interpretation is not made by the Architect before the bid is due, the subcontractor shall base the bid on the greater quantity or most expensive product.
   2. If a conflict is recognized during construction, the subcontractor shall immediately request clarification from the Architect through the Construction Manager per the RFI procedures. Responsibilities for coordination and cooperation of Construction Manager and Subcontractors are defined in Section 01 3100 – Project Management and Coordination.

D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
   2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 10 00
SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for Unit Prices and a Schedule of Unit Prices required.

B. Related Sections:
1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
2. Div. 01 Section "ALLOWANCES" for work under an Allowance and based on Unit Prices.
3. Individual specification sections involving Unit Prices.

1.02 PRICE AND PAYMENT PROCEDURES

A. Provide Unit Prices for items scheduled, for inclusion in Contract, as basis for additions to or deductions from Contract Sum if the scope of Work or estimated quantities of Work required by the Contract Documents are unknown at time of Bidding or are increased or decreased.
1. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the Unit Price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated herein.
2. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
3. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor’s overhead and profit for each separately identified item.

B. Measurement Procedures:
1. Measurement methods are indicated in schedule of Unit Prices below. In the event of conflict between measurement methods in this Section and the requirements of Drawings or individual Specification section, request decision from Architect before proceeding. Quantities and measurements indicated are for bidding and Contract purposes only. Actual quantities and measurements supplied or placed in the Work will determine payment.
a. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work involving Unit Prices.
2. Contractor shall take measurements and compute anticipated and actual quantities of Unit Price Work performed by Contractor.
a. Measurements and quantities will be verified by Architect by way of signatures on surveyor’s field notes.
b. Assist by providing necessary equipment, workers, and survey personnel as required.
3. Architect will verify the actual quantities and classifications of Unit Price Work performed by Contractor. Architect will review with Contractor the Architect’s preliminary determinations on such matters before rendering a written decision thereon by recommendation of an Application for Payment or otherwise. Architect’s written decision thereon will be final and binding (except as modified by Architect to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following subparagraphs.
a. Within 30 days of Architect’s written decision under the preceding paragraph,
Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an
adjustment in the Contract Price if:
1) the quantity of any item of Unit Price Work performed by Contractor differs
   materially and significantly from the estimated quantity of such item;
2) there is no corresponding adjustment with respect to any other item of Work;
and
3) Contractor believes that Contractor is entitled to an increase in Contract
   Price as a result of having incurred additional expense or Owner believes
   that Owner is entitled to a decrease in Contract Price, and the parties are
   unable to agree as to the amount of such increase or decrease.

4. Owner reserves the right to establish the final quantity of work-in-place by independent
   quantity survey, measure, or count.

C. Measurement Devices: Weigh scales and metering devices shall be inspected, tested and
certified by the appropriate state Department of Weights and Measures within the past year.
Platform scales shall be of sufficient size and capacity to accommodate the conveying vehicle.

D. Measurement Methods:
1. Measurement by Weight: Measure concrete reinforcing steel, rolled or formed steel or
   other metal shapes by handbook weights. Welded assemblies will be measured by
   handbook or scale weight.
2. Measurement by Volume: Measure by cubic dimension using mean length, width and
   height or thickness.
3. Measurement by Area: Measure by square dimension using mean length and width or
   radius.
4. Linear Measurement: Measure by linear dimension, at the item centerline or mean chord.
5. Stipulated Price Measurement: Items measured by weight, volume, area, or linear means
   or combination, as appropriate, as a completed item or unit of the Work.

E. Payment Procedures:
1. Payment for Work governed by unit prices will be made on the basis of the actual
   measurements and quantities of acceptable Work incorporated in or made necessary by
   the Work, multiplied by the unit price.
2. Payment includes full compensation for all required labor, Products, tools, equipment,
   plant, transportation, services, and incidentals, and for erection, application, or installation
   of an item of the Work.
3. Adjustments to Contract Sum will be made by Change Order based on net cumulative
   change for each item of the Work.
4. Payment will not be made for the following:
   a. Products wasted.
   b. Products disposed of in an unacceptable manner.
   c. Products determined as unacceptable before or after placement.
   d. Products not completely unloaded from the transporting vehicle.
   e. Products placed beyond the lines and levels of the required Work.
   f. Products remaining on hand after completion of the Work.
   g. Loading, hauling, and disposing of rejected Products.

1.03 DEFINITIONS

A. Unit Price: An amount incorporated in the Owner-Contractor Agreement as a price per unit of
measurement for materials, equipment, or services, or a portion of the Work. Unit Prices shall
remain applicable during the duration of the Work. Unit prices include complete cost of
necessary products, tools, equipment, fabrication, transportation, services and incidentals; and
installation, plus costs for insurance, taxes, overhead, and profit.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SCHEDULE OF UNIT PRICES FOR DIV. 03 - CONCRETE

A. Unit Price No. 1: Patching holes in concrete walls
   1. Description: Patching of holes in concrete remaining from removed anchors according to Div. 01 Section "EXECUTION" not otherwise indicated in the Contract Documents.
   2. Unit of Measurement: Per hole.

B. Unit Price No. 2: Cutting and patching of concrete floor slabs
   1. Description: Cutting of new or existing concrete floor slabs up to 4 inches thick, removal and excavation as required, and subsequent backfill, compaction, and patching of concrete according to Div. 01 Section "EXECUTION" not otherwise indicated in the Contract Documents.
   2. Unit of Measurement: Square feet of concrete removed.

C. Unit Price No. 3: Replacing conduit anchors in concrete walls
   1. Description: Cutting of new or existing concrete floor slabs up to 4 inches thick, removal and excavation as required, and subsequent backfill, compaction, and patching of concrete according to Div. 01 Section "EXECUTION" not otherwise indicated in the Contract Documents.
   2. Unit of Measurement: Square feet of concrete removed.

3.02 SCHEDULE OF UNIT PRICES FOR DIV. 04 - MASONRY

A. Unit Price No. 4: Masonry cleaning
   1. Description: Remove gum, paint and other markings, and graffiti from exterior and interior masonry surfaces as specified in Div. 04 Section "MASONRY CLEANING."
   2. Unit of Measurement: Square foot of surface area cleaned.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."

B. Unit Price No. 5: Repointing masonry mortar joints
   1. Description: Repoint exterior masonry joints as specified in Div. 04 Section "MASONRY RESTORATION."
   2. Unit of Measurement: Linear foot of joint.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."

C. Unit Price No. 6: Patching of damaged and deteriorated brick masonry units
   1. Description: Patch damaged and deteriorated masonry units as specified in Div. 04 Section "MASONRY RESTORATION."
   2. Unit of Measurement: Square foot of wall surface.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."

D. Unit Price No. 7: Patching of damaged and deteriorated stone
   1. Description: Patch damaged and deteriorated stone as specified in Div. 04 Section "MASONRY RESTORATION."
   2. Unit of Measurement: Square foot of wall surface.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."
E. Unit Price No. 8: Replacement of damaged and deteriorated masonry units
   1. Description: Replace damaged and deteriorated masonry units as specified in Div. 04 Section "MASONRY RESTORATION."
   2. Units of Measurement: Per masonry unit for brick.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."

F. Unit Price No. 9: Replacement of damaged and deteriorated stone
   1. Description: Replace damaged and deteriorated masonry units as specified in Div. 04 Section "MASONRY RESTORATION."
   2. Units of Measurement: Square foot of wall surface.
   3. Quantity Allowance: Coordinate Unit Price with allowance adjustment requirements of Div. 01 Section "ALLOWANCES."

3.03 SCHEDULE OF UNIT PRICES FOR DIV. 05 - METALS
A. Unit Price No. 10: Miscellaneous and structural steel
   1. Description: Miscellaneous lintels and other supports not otherwise indicated in the Contract Documents, according to Div. 05 Section "STRUCTURAL STEEL FRAMING" and Div. 05 Section "METAL FABRICATIONS."
   2. Unit of Measurement: Cost in place of pounds of fabricated steel as indicated on itemized invoice of steel supplier and verified by Architect.

3.04 SCHEDULE OF UNIT PRICES FOR DIV. 08 - OPENINGS
A. Unit Price No. 11: Removal and replacement of damaged and non-functioning door hardware
   1. Description: Remove damaged and improperly functioning hardware over and above those as indicated on Drawings, if any, and replace with new in accordance with Div. 08 Section "DOOR HARDWARE."
   2. Unit of Measurement: a. Hardware: Per item of hardware (list Unit Prices separately by hardware items anticipated)

3.05 SCHEDULE OF UNIT PRICES FOR DIV. 09 - FINISHES
A. Unit Price No. 12: Unsatisfactory Floor Substrate Remediation - Moisture Mitigation System
   1. Description: Provide moisture mitigation system as specified in Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION" in the event tests results are unsatisfactory.
   2. Unit of Measurement: Square foot of surface area.

B. Unit Price No. 13: Unsatisfactory Floor Substrate Remediation - Underlayment
   1. Description: Provide moisture mitigation system as specified in Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION" in the event underlayment is required over moisture mitigation system.
   2. Unit of Measurement: Square foot of surface area per 1/8 inch of underlayment thickness.

C. Unit Price No. 14: Repainting
   1. Description: Clean, prepare, and repaint interior surfaces as specified in Div. 09 Section "PAINTING."
   2. Unit of Measurement: Square foot of surface area by surface type as follows:
      a. Concrete unit masonry.
      b. Gypsum board.
      c. Doors and frames.
END OF SECTION 01 22 00
SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for Alternates[ and a Schedule of Alternates required].

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Owner-Contractor Agreement: Alternates accepted by Owner for incorporation into the Work.

1.02 DEFINITIONS

A. Alternate: An amount proposed by Contractor for certain work defined in the Contract Documents that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if accepted by Owner and enumerated in the Agreement.
   2. The cost or credit for each Alternate is the net addition to or deduction from the Contract Sum to incorporate Alternate into the Work. No other adjustments are made to the Contract Sum.

1.03 PRICE AND PAYMENT PROCEDURES

A. Certain designated items are specified as Alternates in the Contract Documents. Provide Alternate costs for inclusion in Contract Sum if accepted by Owner.

B. Alternates will be accepted or rejected at the sole option of Owner. Contract Sum and Contract Time will be adjusted to reflect accepted Alternates.

C. Immediately following Contract award, notify each party involved, in writing, of the status of each Alternate. Indicate if Alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to Alternates.

D. Execute accepted Alternates under the same conditions as other work of the Contract.

E. Revise or adjust affected adjacent work as required to integrate work of accepted Alternates into Project.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SCHEDULE OF ALTERNATES

A. Following is a brief summary list of required Alternates. Refer to Drawings and individual Specification Sections for additional requirements for each Alternate.

B. Alternate No. 1: John R. King Academy temperature control system
   1. See Project Cover Sheet for subject building for description of Base and Alternate bid items

C. Alternate No. 2: Bates Academy temperature control system
   1. See Project Cover Sheet for subject building for description of Base and Alternate bid items

D. Alternate No. 3: Keidan Special Education Center work
   1. See Project Cover Sheet for subject building for description of Base and Alternate bid items

E. Alternate No. 4: Alternate Floor Covering Adhesive
   1. Base Bid: Provide floor covering manufacturer's standard adhesives for installation. Do not include the cost of the alternate adhesive in the Base Bid.
   2. Alternate Bid: Provide alternate floor covering adhesive as specified in Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

F. Alternate No. 5: Moisture Mitigation System
   1. Base Bid: Do not include the cost of the moisture mitigation system in the Base Bid.
   2. Alternate Bid: Provide moisture mitigation system to cover entire floor area as specified in Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

G. Alternate No. 6: Underlayment Over Moisture Mitigation System
   1. Base Bid: Do not include the cost of underlayment over the moisture mitigation system in the Base Bid.
   2. Alternate Bid: Provide underlayment over the moisture mitigation system to cover entire floor area as specified in Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

END OF SECTION 01 23 00
SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
   3. Divisions 02 through 49 Sections for specific requirements and limitations for substitutions.

1.02 DEFINITIONS

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

1.03 SUBMITTALS

A. Substitution Requests: Submit a request for each consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles. Combine the request form with supporting documentation under the same transmittal.
   1. Substitution Request Form: Use facsimile of Architect's form provided in the Project Manual (refer to Section 01 2500.13 - Substitution Request Form).
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
      b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, "CLOSEOUT PROCEDURES", 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.
      c. Certificates and qualification data, where applicable or requested.
d. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.

e. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

f. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.

g. Detailed comparison of Construction Manager's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery, including a copy of the purchase order with date of receipt for requests occurring after award.

h. Comparison of cost information, including a proposal of change in the Contract Sum, if applicable.

i. Construction Manager'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.

j. Construction Manager's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Construction Manager of acceptance or rejection of proposed substitution within 15 working days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later. Architect will mark Substitution Request Form to indicate action taken, as follows:

a. Final Release: Where marked “ACCEPTED”, that part of work to include substitution may proceed.

b. Final But Restricted Release: Where marked “ACCEPTED AS NOTED”, that part of work to include substitution may proceed provided all requirements indicated are met, final acceptance will depend on that compliance.

c. Final Rejected: Where marked “NOT ACCEPTED”, that part of work to include substitution may not proceed.

d. Substitution for Convenience request submitted after the pre-award deadline described below will be marked “RECEIVED TOO LATE”. Architect will return requests without review, except to record noncompliance with these requirements.

1.04 QUALITY ASSURANCE

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

1.05 PROCEDURES

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

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 5 working days prior to the last scheduled Addendum if submit-
SUBSTITUTION PROCEDURES

1. Conditions: Architect will consider Construction Manager's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied and/or it is found not to be a Substitution for a Cause, Architect will return requests without action, except to record noncompliance with these requirements:
   a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   b. Substitution request is fully documented and properly submitted.
   c. Requested substitution will not adversely affect Construction Manager's construction schedule.
   d. Requested substitution has received necessary approvals of authorities having jurisdiction.
   e. Requested substitution is compatible with other portions of the Work.
   f. Requested substitution has been coordinated with other portions of the Work.
   g. Requested substitution complies with Project Sustainability Requirements.
   h. Requested substitution provides specified warranty.
   i. 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: Architect will consider requests for substitution if received during the bid phase and no less than 5 working days prior to the last scheduled Addendum. Requests received after award will be processed by the Architect at a fixed charge of $500. This charge will apply regardless of whether the request is approved or not. Submit requests for substitution immediately upon discovery of its potential advantage to the project, but not later than 15 working days prior to time required for preparation and review of related submittals in order to stay on approved project schedule.

1. Conditions: Architect will consider Construction Manager's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
   a. Requested substitution 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 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 including payment for the fixed charge.
   e. Requested substitution will not adversely affect Construction Manager'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. Requested substitution complies with Project Sustainability Requirements.
   k. 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.
C. Substitutions will not be considered under one or more of the following circumstances:
   1. When they are indicated or implied on shop drawings or product data submittals, without having received prior approval.
   2. Without a separate written request.
   3. When acceptance will require revisions to Contract Documents.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 25 00
SECTION 01 25 00.13 – SUBSTITUTION REQUEST FORM

NOTE: The applicant has the burden of demonstrating that the substituted product has equal or superior quality, performance and life expectancy, that the substitute materials and equipment conform to the Contract Documents, and that all dimensions, arrangements, design, construction details and other features are suited to the specified purpose. Attach additional sheets as necessary. Payment as described in Section 01 2500 – Substitution Requests is due prior to review of Substitution for Convenience requests.

TO: STANTEC

PROJECT: ________________________________________________________________________

We hereby submit for your consideration, the following products instead of the specified items for the above project:

Drawing: Spec Section: Paragraph: Specified Item: Proposed Substitution: ________________________________________________________________________

Attach complete product and technical data, laboratory tests, certificates, "CLOSEOUT PROCEDURES", and engineering calculations, if applicable. Include complete information on changes to Drawings and/or Specifications which proposed substitution will require for its proposed installation. Submit all necessary samples and substantiating data to provide equal quality and performance to that which is specified. Clearly mark manufacturer’s literature to indicate equality in performance.

A. Reason for request? Substitution for Cause _______ Substitution for Convenience _______

If cause, explain: ________________________________________________________________________

B. Does the substitution affect dimensions shown on Drawings? Yes ______ No ______

If yes, clearly indicate changes: ________________________________________________________________________

C. Will the undersigned pay for changes to the building design, including engineering and detailing costs caused by the requested substitution?

Yes ______ No ______ If no, fully explain: ________________________________________________________________________

D. What effect does the substitution have on other contracts and/or trades? ________________________________________________________________________

E. What effect does the substitution have on applicable code requirements? ________________________________________________________________________

F. Provide itemized comparison between proposed substitution and specified item: ________________________________________________________________________
G. Manufacturer’s warranty of the proposed and specified items are:

Same ______ Different ______ If different explain: ________________________________

H. What effect does the substitution have on the construction schedule? ____________________________

I. Provide accurate cost data comparing proposed substitution with product specified: ____________

CERTIFICATION OF EQUAL PERFORMANCE
AND ASSUMPTION OF LIABILITY FOR EQUAL PERFORMANCE.

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted By (print name) ____________________________

Title ____________________________

Signature Date ____________________________

Company ____________________________

Address ____________________________

Address ____________________________

Telephone ____________________________

Signature must be person having authority to legally bind the Company to the above terms. Failure to provide legally binding signature will result in retraction of approval.

For Use by design Consultant:

_____ ACCEPTED _____ ACCEPTED AS NOTED

_____ NOT RECEIVED _______ TOO LATE

Reviewed By ____________________________

Date ____________________________

REMARKS: ____________________________

____________________________________

____________________________________

____________________________________

____________________________________

END OF SECTION 01 25 00.13
SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General project coordination.
   2. Administrative and supervisory personnel.
   3. Coordination drawings.
   4. Request for Information (RFI).
   5. Project meetings.
   6. Above-Ceiling Inspection.

1.02 DEFINITIONS

A. RFI: Request from Construction Manager seeking interpretation or clarification of the Contract Documents.
   1. Improper RFI: RFI not prepared in accordance with requirements of this Section, including requirements for graphic solution, where appropriate.
   2. Frivolous RFI: RFI that requests information that is clearly indicated on or reasonably inferable from the Contract Documents.

1.03 COORDINATION OF WORK / COOPERATION

A. The Construction Manager and each Subcontractor shall recognize the complex nature of the Project, the sequential nature of contracts and the concurrent and ongoing operations of the Owner and other contractors with the Work of this Project. All Contractors and Subcontractors are required to review, discuss and coordinate their Work with the Work of others, as well as Construction Manager with regard to sequence, timing, built-in Work and equipment, layout, location, compatibility of materials and sizes and required clearances prior to beginning the work to avoid construction delays which impact the Owner's occupancy of the facility. Since the Work of each contractor will depend upon interface with the Work of other contractors, changes in the scheduling, procedures, Work or Project conditions of a contractor may affect the scheduling procedures, Work or Project conditions of other contractors.

B. The Construction Manager and each Subcontractor shall coordinate construction operations in various sections of the technical specifications to assure efficient and orderly installation of each part of the Work that depends on each other for proper installation, connection, fit and operation. Each contractor shall:
   1. Schedule operations in the 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 assure maximum accessibility for required maintenance, service and repair.
   3. Make provisions to accommodate items scheduled for later installation.
   4. Provide to all other trades all information (drawings, diagrams, templates, embedments, etc.) necessary for the coordination of the Work.

C. The completion of the Project within the prescribed time is dependent upon the close and active cooperation and open discussions of all those involved, therefore, it is expressly understood and agreed that each Subcontractor shall layout and install its Work at such time and in such
manner as not to delay or interfere with the carrying forward of the Work of other subcontrac-
tors. Observation of the Work by others shall not relieve Subcontractor from its responsibility for
coordination, supervision, or scheduling and direction of the Work.

D. Subcontractors are to report in a prompt manner any interference, discrepancies or incompati-
bilities discovered to Construction Manager whose decision as to the Subcontractor at fault and
as to the manner in which the matter may be resolved, shall be binding and conclusive on con-
tractors involved. Construction Manager may direct layout or location changes as required to
make the entire work fit together. Reasonable changes of this nature will not entitle any Sub-
contractor to an increase in contract price.

E. Failure of a Subcontractor to notify other subcontractors and Construction Manager of a poten-
tial interference, incompatibility, or discrepancy and any failure to coordinate Work with that of
other Subcontractors prior to installation and/or fabrication shall be at the Subcontractor’s risk.

F. Due to the nature of the site’s existing areas, the sequence of Work must be scheduled and co-
ordinated with the Owner’s ongoing operations to minimize disruptions and/or disturbances to
existing surrounding areas. Each segment of the Work shall be coordinated with Construction
Manager prior to proceeding.

G. Conservation: Coordinate construction activities to ensure that operations are carried out with
consideration given to conservation of energy, water, and materials. Coordinate use of tempo-
rary utilities to minimize waste.
   1. Salvage materials and equipment involved in performance of, but not actually incorpo-
      rated into, the Work. Refer to other Sections for disposition of salvaged materials that
      are designated as Owner's property.

1.04 COORDINATION DRAWINGS

A. Provide coordination drawings for Erma Henderson Upper School according to the require-
ments in individual Sections, for all above-ceiling conditions, and additionally where installation
is not completely indicated on Shop Drawings, where limited space availability necessitates co-
ordination, or if coordination is required to facilitate integration of products and materials fabri-
cated or installed by more than one entity.

B. Construction Manager and subcontractors shall be responsible for developing coordination
drawings and participating in coordination meetings as defined herein, and shall include the cost
for such Work in its Bid Proposal.

C. Coordination Drawings shall be utilized to establish installation sequence, resolve trade coordi-
nation issues prior to installation and to make the most efficient use of space allocated for sys-
tems such as mechanical/electrical/plumbing installations without sacrifice to systems perform-
ance. This is also required to determine inter-relationships and possible interferences between
all of the trades’ Work and the architectural or structural features.

D. Construction Manager and subcontractors shall attend coordination meetings. Representatives
are required to be familiar with the Work and have the expertise and authority to answer ques-
tions and make decisions and changes to its systems at the meetings.

E. Assume that each floor or area will require several meetings. Development of coordination
drawings will be by area and floor with order of priority established by the Construction Man-
ager.
F. The 3D coordination modeling process does not replace the standard submittal process and will not be considered as a submittal. Exceptions may be made with approval through the Construction Manager for the model to be used as part of the submittal review process.

G. Coordination Drawings, General:
1. Coordination Drawings: Prepare coordination digital data files in accordance with the following requirements:
   a. File Submittal Format: Submit coordination drawing files using Portable Data File (PDF) format in accordance with requirements of Division 01 Section “Submittal Procedures.”
   b. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the contractor's responsibility. If the Architect determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Architect will so inform the Construction Manager, who shall make changes as directed and resubmit.

1.05 KEY PERSONNEL
A. Key Personnel Names: Within 15 working 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 telephone numbers, including office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
   1. Post copies of list in project meeting room, in temporary field office and by each temporary telephone. Keep list current at all times.

1.06 REQUESTS FOR INTERPRETATION (RFIS)
A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Construction Manager shall prepare and submit an RFI in the form specified.
   1. Architect will return RFI's submitted to Architect by other entities controlled by Construction Manager with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Construction Manager'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 Construction Manager.
   5. Name of Architect.
   6. RFI number, numbered sequentially.
   7. RFI subject.
   8. Specification Section number and title and related paragraphs, as appropriate.
   9. Drawing number and detail references, as appropriate.
   10. Field dimensions and conditions, as appropriate.
   11. Construction Manager's suggested resolution. If solution(s) impacts the Contract Time or the Contract Sum, Construction Manager shall state impact in the RFI.
   12. Construction Manager'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 a software-generated form with substantially the same content as indicated above, acceptable to Architect. The RFI form is to be consistent throughout the duration of the project.
   1. Attachments shall be electronic files submitted in both Microsoft Word and PDF format.

D. Construction Manager’s Action: Construction Manager will review and sign each RFI prior to submitting to the Architect.
   1. All RFIs must be submitted through the Construction Manager. RFI from Subcontractors or material suppliers submitted directly to Architect will be returned unanswered.

E. Architect’s Action: Architect will review each RFI, determine action required, and respond. Allow 5 working days for Architect’s response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
   1. The following unnecessary and frivolous RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Time or the Contract Sum.
      e. Requests for interpretation of Architect’s actions on submittals.
      f. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect’s action may include a request for additional information, in which case Architect’s time for response will date from time of receipt of additional information.
   3. Architect’s action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Construction Manager to submit Change Proposal.
      a. If Construction Manager believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 working days of receipt of the RFI response.

F. On receipt of Architect’s action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Construction Manager disagrees with response.

G. RFI Log: Prepare, maintain, and submit a tabular log of RFI’s organized by the RFI number. Submit log weekly. Use CSI Log Form 13.2B or a software log with not less than the following:
   1. Project name.
   2. Name and address of Construction Manager.
   3. Name and address of Architect.
   4. RFI number including RFIs that were dropped and not submitted.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect’s and Construction Manager’s response was received.

H. Improper or Frivolous RFI:
   1. Will be returned unanswered, will be removed from Construction Manager’s RFI log, and number assigned will be assigned to subsequent RFI.
   2. Construction Manager’s request, after notification by Architect that RFI is improper or frivolous, will be processed with processing costs charged to Construction Manager as follows:
a. Construction Manager shall reimburse Owner for Architect’s account for time spent in processing improper and frivolous RFIs billed at the Architect’s hourly billing rate.

b. Cost will be deducted from trade contractor’s retention as a deduct Change Order.

1.07 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Architect’s Digital Data Files: Digital data files of Architect’s BIM model will be provided by Architect for Construction Manager’s use during construction in preparing coordination drawings only. Digital data files will not be provided for use in preparing submittals.

   1. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
   2. The digital data files are available in the version of software program they were created in. No translation by the Architect will be provided.
   3. Construction Manager shall execute a data licensing agreement in the form of Agreement included in Section 00 3100.13 - BIM Release Form.

   a. Subcontractors, and other parties granted access by Construction Manager to Architect’s digital data files shall execute a data licensing agreement in the form of Agreement included in Section 00 3100.13 - BIM Release Form.

B. Web-Based Project Software: Construction Manager shall provide, administer, and use web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.

   1. Communications requiring Architect review, including RFIs, Submittals, and Substitution Requests, shall be emailed to the Architect. Architect shall not be required to download and upload files to Construction Manager’s web-based Project software.

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

   1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
   2. Name file with submittal number or other unique identifier, including revision identifier.
      a. Refer to Division 01 Section “Submittal Procedures” for submittal format and file naming conventions.
   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.08 PROJECT MEETINGS

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Construction Manager will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Responsibilities and personnel assignments.
   b. Tentative construction schedule.
   c. Phasing.
   d. Critical work sequencing and long lead items.
   e. Designation of key personnel and their duties.
   f. Lines of communications.
   g. Use of web-based Project software.
   h. Procedures for processing field decisions and Change Orders.
   i. Procedures for RFIs.
   j. Procedures for testing and inspecting.
   k. Procedures for processing Applications for Payment.
   l. Distribution of the Contract Documents.
   m. Submittal procedures.
   n. Preparation of Record Documents.
   o. Use of the premises.
   p. Work restrictions.
   q. Working hours.
   r. Owner's occupancy requirements.
   s. Responsibility for temporary facilities and controls.
   t. Procedures for moisture and mold control.
   u. Procedures for disruptions and shutdowns.
   v. Construction waste management and recycling.
   w. Parking availability.
   x. Office, work, and storage areas.
   y. Equipment deliveries and priorities.
   aa. First aid.
   cc. Progress cleaning.

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

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each critical construction activity that requires coordination with other construction.

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

   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 RFI's.
      d. Related Change Orders.
      e. Purchases.
      f. Deliveries.
      g. Submittals.
      h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written recommendations.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. 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: Construction Manager will schedule and conduct a Project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; 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. Submittal of written "CLOSEOUT PROCEDURES".
   d. not used
   e. Requirements for preparing operations and maintenance data.
   f. Requirements for demonstration and training.
   g. Preparation of Construction Manager's punch list.
   h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
   i. Submittal procedures.
   j. Installation of Owner's furniture, fixtures, and equipment.
4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Construction Manager will conduct progress meetings at regular intervals as required by the Project.
1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in plan-
Project Management and Coordination

1. Meetings:
   - Attendance: 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.

2. Coordination Meetings:
   - Construction Manager will conduct coordination meetings at regular intervals as required by the Project. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
   - Attendees: Each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work. Representatives of Owner and Architect may attend.
   - Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
     - Combined Construction Manager's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Construction Manager'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.
     - Other items:
       1) Interface requirements.
       2) Sequence of operations.
       3) Status of submittals.
       4) Deliveries.
       5) Off-site fabrication.
       6) Access.
       7) Site utilization.
       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 RFI's.
       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.

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.
     - Construction Manager'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 Construction Manager'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.
     - Other items:
       1) Review schedule for next period.

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

F. Coordination Meetings:
   - Construction Manager will conduct coordination meetings at regular intervals as required by the Project. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
   - Attendees: Each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work. Representatives of Owner and Architect may attend.
   - Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
     - Combined Construction Manager's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Construction Manager's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether
schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise combined Construction Manager's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.

c. Review present and future needs of each contractor present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Deliveries.
   5) Off-site fabrication.
   6) Access.
   7) Site utilization.
   8) Temporary facilities and controls.
   9) Work hours.
   10) Hazards and risks.
   11) Progress cleaning.
   12) Quality and work standards.
   13) Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.09 ABOVE-CEILING INSPECTION

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.

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

3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Above-Ceiling Inspection: Construction Manager will schedule an Above-Ceiling Inspection with the Architect following the completion of all mechanical, electrical, plumbing, fire suppression, and other above-ceiling work and before the work is covered with finished ceiling materials. Notify the Architect of inspection date no later than 15 working days before inspection is scheduled to occur.

1. Architect will notify Construction Manager of work that requires correction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 31 00
ELECTRONIC EXCHANGE AGREEMENT

THIS AGREEMENT is made and entered into effective January 1, 2020 (the “Agreement Date”) by and between:

“OWNER”
Name: OWNER COMPANY NAME
Address: Owner street address, including city, prov/state and zip or post code
Phone: Phone Number extension here or delete Fax: Fax Number
Representative: Owner representative and title

“RECIPIENT”
Name: RECIPIENT COMPANY NAME
Address: Recipient street address, including city, prov/state and zip or post code
Phone: Phone Number extension here or delete Fax: Fax Number
Representative: Recipient representative and title

“PROJECT”
Name: Enter project name and number if desired
Address: Enter project location address including city, province or state and zip or post code

WHEREAS, Stantec and its consultants have prepared for this Name of Client, computer-aided drawings for the construction of the Project including a Building Information Model (“BIM”) and/or other electronic data (hereinafter referred to jointly as “Electronic Data”) – graphic or non-graphic in nature, which do not constitute part of the Contract Documents as described under the Recipient’s Contract with the Owner.

WHEREAS, Recipient has requested that it be provided with the Electronic Data for Recipient’s use(s) solely on this project. Stantec agrees to provide Electronic Data to support the following (check all that apply):

☐ Construction Modeling
☐ Clash Detection
☐ Timeline Simulations
☐ Logistics planning
☐ Quantity extraction / Cost Estimating
☐ Shop Drawings
☐ Bidding
☐ Other  click and insert other uses here or delete if not applicable

NOW, THEREFORE, to effect the arrangement to transfer Electronic Data to Recipient, the Parties agree as follows:

That the Recipient may use the Electronic Data to assist it solely in connection with the uses stated above and no changes are to be made without Stantec’s prior written consent.

That the Electronic Data is being provided to Recipient in the following format(s) (check all that apply):

3 Dimensional Format(s):
☐ Revit version enter version year or delete if not applicable (.rvt)
☐ Navisworks version enter version year or delete if not applicable (.nwc/.nwd/.nwf)
☐ AutoCAD version enter version year or delete if not applicable (.dwg)
☐ AutoCAD version enter version year or delete if not applicable (.dxf)
☐ MicroStation version enter version year or delete if not applicable (.dgn)
☐ IFC  enter format type or delete if not applicable (IFC)
☐ Other  click and insert other uses here or delete if not applicable

2 Dimensional Format(s):
☐ AutoCAD version enter version year or delete if not applicable (.dwg)
☐ AutoCAD version enter version year or delete if not applicable (.dxf)
The Recipient acknowledges that Stantec may change the software version and/or build for any application(s) used to create Electronic Files as needed at any time. Stantec will not supply alternate versions or formats unless agreed to in writing.

It is understood that any Electronic Data provided including BIM information is not a substitute for final hard copy Construction Documents. The Electronic Data is not complementary to the final Construction Documents and it is understood that Electronic Data can not be relied upon to be coordinated, accurate, complete, and can not be relied upon to represent correct quantities. Recipient also acknowledges that subsequent BIM updates may contain significant changes that might conflict with legacy models and therefore be incompatible. It is understood that the Electronic Data supplied under this agreement was prepared for Stantec’s design purposes and not for the Recipient’s uses, and that Recipient will not use the Electronic Data as a substitute for its traditional processes and own technology. Stantec makes no representation about the electronic data that can be relied upon by the Recipient or user for any purpose.

Check the paragraph that applies:

☐ The Recipient understands that this is a onetime exchange and that updated files will not be provided.

☐ The Recipient recognizes that Stantec’s Electronic Data development does not follow the Recipient’s schedule for their intended use of the files. Therefore, after the first exchange of Electronic Data, the Recipient may request updated files from Stantec no sooner than enter number of weeks weeks from first exchange and not more frequently than enter number of weeks weeks thereafter. It is at Stantec’s sole discretion to provide updated files outside of this established schedule.

☐ The Recipient agrees that Stantec will issue additional electronic files only at scheduled project milestones. Transmission of the files may follow the milestone date by up to enter number of days days. It is at Stantec’s sole discretion to provide updated files outside of this established schedule.

☐ The Recipient is being granted access to a cloud-based system, where data is being updated on a continuous basis. The data available for download may not represent the most up to date files, and the Recipient may or may not receive notifications that new information is available.

The Recipient recognizes that the condition of the Electronic Data may warrant a live work session with Stantec to explain changes or conditions in the model that may impact the Recipient’s ability to use the Electronic Data for those purposes listed above or that it might impact the design of the project. In each such case Recipient agrees to participate in said work session and share the changes to the Electronic Data and its observations it has made through the use of the Electronic Data.

The Recipient agrees that Stantec’s title block on each drawing contained with the Electronic Data must be deleted, and this Agreement grants no right to reproduce the title block.

Under no circumstances shall the providing of the Electronic Data be deemed a sale of a product or good, and neither the Owner nor Stantec or their Consultants make any "CLOSEOUT PROCEDURES", express or implied, including warranty of fitness for a particular purpose or warranty of merchantability or other any other warranty.

It is understood that the automated conversion of information and data from the system and format used by Stantec to an alternate system or format cannot be accomplished without the risk of introducing inexactitudes, anomalies, and/or errors. Recipient also understands the inherent risk of data loss or corruption from the use and/or storage of Electronic Data. Recipient also understands that the Electronic Data may be incomplete and/or uncoordinated with other portions of the project design, or that it might change through the term of the Project, and Recipient must verify all information as contained in the Contract Documents before it uses it for any purpose. Recipient also understands that this agreement or the Recipient’s use of the Electronic Data does not relieve it of its other contractual responsibilities under the Construction Contract, that it remains fully responsible for its shop drawings and other submittals, and remains responsible to ensure that the electronic design data is in conformity with the design shown on the contract documents to the extent necessary to properly prepare its shop drawings or perform its work. Accordingly, the Digital Files, provided by Stantec, are for informational purposes only and are not
intended to be directly incorporated into the Contractor’s end product. Recipient remains fully responsible for determining its own means, methods, sequences and procedures, and is not entitled to rely upon any information or assumptions related to means, methods, sequences or procedures assumed by Stantec, project engineers or other designers in developing the Electronic Data, whether the information or assumptions are shared with the Recipient or not. Recipient agrees to assume all risks associated with the use, conversion or storage of the Electronic Data.

Recipient also recognizes that changes or modifications to Stantec’s instruments of professional service introduced by anyone other than Stantec may result in adverse consequences which cannot be predicted nor controlled and understood.

Therefore, and in consideration of the Owner’s agreement to deliver their instruments of professional service in machine readable form, Recipient agrees, to the fullest extent permitted by law, to defend, hold harmless and indemnify the Owner and Stantec and their consultants, and each of their officers, employees, and affiliated and successor companies from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney’s fees, whether asserted as a breach of contract, breach of warranty, negligence, misrepresentation or other tort, or otherwise, arising out of or in any way connected with the use, conversion, modification, misinterpretation, misuse, or reuse by the Recipient or others for whom the Recipient is responsible of the Electronic Data provided by Stantec under this Agreement.

Recipient agrees not to reverse-engineer, or use in any way, the BIM or its contents (including Revit families or objects) provided by Stantec except to use specifically for this project and only for the uses described herein. Recipient will not export or share the Electronic Data or any unique or novel aspects of Stantec’s model(s) or Stantec’s BIM process with any third party, in full or in part, for any reason other than to fulfill the project requirements set forth in this Agreement or in the Recipient’s prime agreement with the Owner.

The Recipient agrees to require its subcontractors who use any of the Electronic Data to sign acceptance of the terms of this agreement as though they/it were the Recipient, by agreement with the Recipient for the benefit of the Owner, Stantec and their officers, employees, and consultants. Use of any medium or files containing the described Electronic Data by any party (the “user”) constitutes acceptance of the terms of this Agreement by the user as though the user were the Recipient described in this Agreement.

This Agreement does not constitute an agreement with Stantec or create any cause of action of any kind in favor of the Recipient, its subcontractor, suppliers or any third party against Stantec or the Owner. This Electronic Exchange Agreement is made solely for the benefit of the Owner, the Recipient, Stantec and its consultants, and no other party is an intended beneficiary of this Agreement.

**RECIPIENT COMPANY NAME**

Name and Title of signor IF NOT KNOWN

By: ________________________________

Signature ______________________________________________________________________

END OF FORM 01 31 00.13
SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
   3. Division 01 Section "Quality Requirements" for submitting test and inspection reports.
   4. Division 01 Section "Closeout Procedures" for submitting "CLOSEOUT PROCEDURES".
   5. Divisions 02 through 49 Sections for specific requirements for submittals in those Sections.

1.02 DEFINITIONS

A. Submittal Compliance Certificate: Certificate submitted by Construction Manager indicating that the Basis of Design product listed in the specifications will be installed. If accepted by Architect, Construction Manager need not submit each Action or Informational Submittal listed in the specification unless otherwise noted.

B. Action Submittals: Written and graphic information that requires Architect's responsive action.

C. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.03 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit electronic PDF of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for each submittal required by the Contract Documents.
      a. Indicate if large submittals, such as HVAC or fire protection, will be divided into multiple parts. Include scheduled dates for each separate part.
   2. Specification Section number and title.
   3. Submittal category (action or informational) and type (product data, sample, test report, etc.).
   4. Name of Subcontractor.
   5. Description of the Work covered.
   6. Scheduled dates for Architect's final release or approval.

B. Preparation:
   1. Coordinate Submittal Schedule with list of subcontracts, the Schedule of Values, and Construction Manager's Construction Schedule.
   2. Preliminary Submittal Schedule: Submit within the first 30 days of construction. List submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacturer or fabrication.
   2. Complete Submittal Schedule: Submit concurrently with first application for payment.
   3. Updated Submittal Schedule: Submit with each subsequent application for payment to reflect current status and changes in timing for submittals.
1.04 SUBMITTAL FORMATS

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

1. Project name.
2. Date.
4. Name of Subcontractor/Construction Manager.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number followed by a decimal point and then a sequential number (i.e. 061000.01). Resubmittals shall include an alphanumeric suffix after another decimal point (i.e. 061000.01.A).
8. Category and type of submittal.
10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will discard submittals received from sources other than Construction Manager.

1. Transmittal Form: Provide locations on form for the following information:
   a. Project name.
   b. Date.
   c. Destination (To:).
   d. Source (From:).
   e. Names of subcontractor, manufacturer, and supplier.
   f. Category and type of submittal.
   g. Submittal purpose and description.
   h. Specification Section number and title.
   i. Drawing number and detail references, as appropriate.
   j. Transmittal number, numbered consecutively.
   k. Submittal and transmittal distribution record.
   l. Remarks.
   m. Signature of transmitter.

2. On an attached separate sheet, prepared on Construction Manager's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.
1.05 SUBMITTAL PROCEDURES

A. General: Electronic copies of 2D CAD Drawings of the Contract Drawings will not be provided by Architect for subcontractor's use in preparing submittals. When requested in writing, Architect will furnish Construction Manager digital data files for use in preparing coordination drawings only.

1. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings.

2. The digital data files are available in the version of software program they were created in. No translation by the Architect will be provided.

3. Construction Manager shall execute a data licensing agreement in the form of Agreement included in Section 00 3100.13 – BIM Release Form.

   a. Subcontractors, and other parties granted access by Construction Manager to Architect's digital data files shall execute a data licensing agreement in the form of Agreement included in Section 00 3100.13 – BIM Release Form.

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

1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.

2. Architect shall not be required to download and upload files to Construction Manager's web-based Project software.

C. 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 different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

   a. Architect and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Submittals Schedule: Comply with applicable Division 01 requirements for list of submittals and time requirements for scheduled performance of related construction activities.

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

1. Initial Review: Allow 10 business days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals is required. Architect will advise Construction Manager when a submittal being processed must be delayed for coordination.

2. Concurrent Review: Where concurrent review of submittals by the Architect's consultants, Owner, or other parties is required, allow 10 business days for initial review of each.

3. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
4. Resubmittal Review: Allow 10 business days for review of each resubmittal.
5. No extension of Contract Time will be authorized because of failure to transmit submittals enough in advance or the Work to permit processing.

F. 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 “REVIEWED” or “REVIEWED AS NOTED”.
   a. The Architect’s review of the Construction Manager’s submittal will be limited to examination of an initial submission and one resubmittal.
      1) The Architect’s review of additional submittals will be made only with the consent of the Owner after notification by the Architect.
      2) Construction Manager shall reimburse Owner for Architect’s account for time spent in processing additional submittals at the hourly billing rate.
      3) Cost will be deducted from trade contractor’s retention as a deduct Change Order.

G. Distribution: Furnish electronic PDF and sample copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

H. Use for Construction: Use only final submittals with mark indicating action taken by Architect and Construction Manager in connection with construction.

1.06 SUBMITTAL COMPLIANCE CERTIFICATES

A. General: If submitting a product listed as Basis of Design in the specifications, the Construction Manager may submit a Submittal Compliance Certificate in lieu of submitting individual Action and Informational Submittals.

B. Acceptance: Architect will review each Submittal Compliance Certificate and will indicate whether certificate is accepted in lieu of individual submittal requirements listed in each specification. Exceptions will be noted by Architect.

1.07 ACTION SUBMITTALS

A. General: Prepare and submit electronic Action Submittals required by individual Specification Sections.

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.
   3. Include the following information, as applicable:
      a. Manufacturer’s catalog cuts.
      b. Manufacturer’s product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
      f. Application of testing agency labels and seals.
      g. Notation of coordination requirements.
      h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams that show factory-installed wiring.
   b. Printed performance curves.
   c. Operational range diagrams.
   d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

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.

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

2. BIM Incorporation: Construction Manager will incorporate subcontractor's Shop Drawing files into BIM established for Project.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

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

2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
   a. Project name and submittal number.
   b. Generic description of Sample.
   c. Product name and name of manufacturer.
   d. Sample source.
   e. Number and title of applicable Specification Section.
   f. Specification paragraph number and generic name of each item.

3. Format: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.

4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Construction Manager.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
6. 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 and Construction Manager 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.

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 Construction Manager 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.

F. Material Safety Data Sheets (MSDSs): Will not be accepted as a submittal.

1.08 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit electronic Informational Submittals required by other Specification Sections.

1. Architect will not return a reviewed electronic PDF.

B. Coordination Drawings: Comply with requirements specified in Section 01 31 00 – Project Management and Coordination.

C. 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.

D. 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.

E. 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.


F. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   a. Name of evaluation organization.
   b. Date of evaluation.
   c. Time period when report is in effect.
   d. Product and manufacturers' names.
   e. Description of product.
   f. Test procedures and results.
   g. Limitations of use.

1.09 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of subcontractor 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.

C. Not used

1.10 CONSTRUCTION MANAGER’S REVIEW

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

B. Construction Manager's Approval: Indicate Construction Manager's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Construction Manager's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

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

2. Construction Manager’s approval indicates that deviations from the Contract Documents, if any, have been specifically and prominently identified as such.

1.11 ARCHITECT’S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.

1. Architect will not review submittals that do not bear Construction Manager's approval stamp and will return without action.

B. Architect’s Action Code: Architect’s review is only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Approval of a specific item does not indicate approval of an assembly of which the item may be a component. Review does not constitute acceptance of deviations from the Contract Documents unless such deviations are clearly and prominently identified as such. Results of the Architect’s review are indicated below. Final Action code by Architect governs.

1. Final Release: Where submittals are marked "REVIEWED," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.

2. Final But Restricted Release: When submittals are marked "REVIEWED AS NOTED" or "Make Corrections Noted", that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

3. 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 notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

a. Do not permit submittals marked "Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

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

F. Architect will return without review submittals received from sources other than Construction Manager.

G. Submittals not required by the Contract Documents will be returned by Architect without action.

1.12 CONSTRUCTION MANAGER’S RESPONSIBILITY

A. Upon return of reviewed submittals, review correction or modification markings and comments on submittal. Do not begin Work for which submittals are required until submittals have been reviewed and returned with action markings permitting release to proceed.

B. Verify field measurements as required prior to fabrication of materials.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 33 00
SECTION 01 33 00.13 - SUBMITTAL COMPLIANCE CERTIFICATE

NOTE: This document serves as a guarantee by the contractor that the Basis of Design product listed in the specifications will be used in the Project. With Architect approval, no additional information is required to be submitted for review, unless indicated below.

Project: ___________________________________________________________________________________

The following product is submitted for consideration:

Spec Section: Paragraph: Specified Item (product name, manufacturer, model number, etc.):

By signing this document, the contractor is committed to use this product.

CONTRACTOR

Date: ______________ Signature: ______________________________________________________________________

Printed Name: ________________________________________________________________________________

Title: ________________________________________________________________________________________

CONSTRUCTION MANAGER

Date: ______________ Signature: ______________________________________________________________________

Printed Name: ________________________________________________________________________________

Title: ________________________________________________________________________________________

ARCHITECT

Date: ______________ Signature: ______________________________________________________________________

Printed Name: ________________________________________________________________________________

Title: ________________________________________________________________________________________

All submittals for this product listed within the specifications are not required for review, EXCEPT THE FOLLOWING, which shall be submitted according to Section 01 3300 - Submittal Procedures.

_____ Certificates _____ Mock-Up

_____ Calculations _____ Operation & Maintenance Data

_____ Test Reports _____ Field Report/Field Testing Results

_____ Installation Instructions _____ Product Data

_____ Installer Qualifications _____ Samples

_____ Maintenance Materials _____ Shop Drawings

_____ Maintenance Listing _____ Sustainable Design Documentation

_____ Manufacturer Qualifications _____ Sample Warranty

01 33 00 - 1
SUBMITTAL COMPLIANCE CERTIFICATE
SECTION 01 35 16 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes special procedures for alteration work.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Div. 01 Section "ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS."

1.02 REFERENCES

A. Definitions:
   1. Alteration Work: Remodeling, renovation, patching and extending existing work including transitions and adjustments, repair of damaged surfaces, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
   2. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
   3. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
   4. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
   5. Replace: To remove and reinstall entire item with new material to match original item, or as otherwise indicated.
   6. Retain: To keep existing items that are not to be removed or dismantled.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate alterations and renovations to expedite completion. Plan and execute the Work accordingly.
   1. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns and use of stairs within Project building(s) and site.
      a. Some work is near circulation patterns and adjacent to restricted areas.
      b. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work.
      c. Access to restricted areas may not be obstructed.

B. Meetings: In accordance with Div. 01 Section "PROJECT MEETINGS."
   1. Preliminary Meeting for Alteration Work: Before starting alteration work, conduct meeting at Project site.
      a. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
         1) Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
         2) Fire-prevention plan - see Div. 01 Section "TEMPORARY UTILITIES."
         3) Governing regulations.
         4) Areas where existing construction is to remain and the required protection.
         5) Hauling routes.
6) Sequence of alteration work operations.
7) Storage, protection, and accounting for salvaged and specially fabricated items.
8) Existing conditions, staging, and structural loading limitations of areas where materials are stored.
9) Qualifications of personnel assigned to alteration work and assigned duties.
10) Requirements for extent and quality of work, tolerances, and required clearances.
11) Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

2. Coordination Meetings for Alteration Work: In addition to progress meetings and preinstallation meetings, conduct meetings specifically for coordinating alteration work at weekly intervals.
   a. Agenda: Review items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
   1) Review present and future needs of each entity present, including review items listed in the "Preliminary Meeting for Alteration Work" Paragraph in this article and the following:
      a) Interface requirements of alteration work with other Project Work.
      b) Access to alteration work locations.
      c) Effectiveness of fire-prevention plan.
      d) Quality and work standards of alteration work.
      e) Change Orders for alteration work.

C. Scheduling: Create an alteration work subschedule within the Contractor's Construction Schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.
   1. Schedule construction operations in sequence required to obtain best Work results.
   2. Coordinate sequence of alteration work activities to accommodate the following:
      a. Owner's continuing occupancy of portions of existing building.
      b. Other known work in progress.
      c. Tests and inspections.
   3. Detail sequence of alteration work, with start and end dates.
   4. Utility Services: Indicate how long and when utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.

1.04 SUBMITTALS, GENERAL

A. Process and transmit in accordance with Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 INFORMATIONAL SUBMITTALS

A. Alteration Work Subschedule: Submit within 7 days of date established for commencement of alteration work.

B. Alteration Work Program: Submit not less than 30 days before work begins.

C. Predemolition Photographs or Video: Submit not less than 7 days before Work begins per Div. 01 Section "PHOTOGRAPHIC DOCUMENTATION."

D. Equipment Data: Submit not less than 7 days before work begins. Show gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure.
1. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.

1.06 QUALITY ASSURANCE

A. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.

B. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.

1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
3. List cleaning chemicals to be used. Identify potential harmful effects of chemicals on adjacent, unprotected surfaces and surroundings including structures, vehicles, vegetation, and soils.

PART 2 - PRODUCTS

2.01 MATERIALS

A. New Materials:
1. Provide new materials to match existing adjacent materials for closing of openings, repairs, and reconstructions where suitable salvaged materials do not exist, are insufficient in quantity, or where reuse is not permitted.
2. Match existing materials in material, type, size, quality, color, finish, and other attributes.

B. Reused Materials:
1. Clean and prepare salvaged materials for reuse.
2. Do not use materials with objectionable chips, cracks, splits, dents, scratches, or other defects.
3. Repair operable items to function properly.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Comply with Div. 01 Section "EXAMINATION AND PREPARATION."

B. Test materials to be used in repairs for compatibility with existing materials; do not use incompatible materials.

C. Notify Architect of visible damage or changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing or thawing, or from structural defects including cracks, movement, or distortion.

1. Do not proceed with the work in question until directed by Architect.
3.02 ALTERATION PROCEDURES

A. Engage qualified specialists to perform specialty work.
B. Install products and finish surfaces as specified in individual sections, or where no Specification Section for new work exists, to match existing.
C. Refinish visible surfaces to specified condition, with neat transition to adjacent surfaces.
D. Finish patches to provide uniform color and texture over entire surface, with repairs not discernible from normal viewing distance. If finish cannot be matched, refinish entire surface to nearest intersections. Comply with Div. 01 Section "CUTTING AND PATCHING."
E. Transitions and Adjustments: Where walls or ceilings are removed to extend one finished area into another with formerly adjacent spaces becoming one, patch and repair floor, wall, and ceiling surfaces in the new space to smooth planes. Provide even, finished surfaces of uniform finish, color, texture, and appearance.
   1. Floors: Remove in-place floor coverings and replace with new materials if necessary.
   2. Walls: Remove in-place wall coverings and replace or refinish with new materials if necessary.
   3. Ceilings: Rehang ceilings if necessary to provide an even-plane surface.
   4. Alignment: Where new work abuts or aligns with existing, provide smooth and even transition without breaks, steps, or bulkheads. Where a change in plane of 1/4 inch or more occurs, submit recommendation to Architect for transition.
F. Utilities: Where alterations expose mechanical, electrical, and similar utility components that were previously concealed, construct enclosures matching adjacent construction to conceal utility components in completed work.
   1. In addition to specified replacement of equipment and fixtures, restore mechanical and electrical systems to full operational condition.
   2. Patch holes in exposed surfaces left by removal of mechanical and electrical components.
G. Fire-Rated Assemblies:
   1. Patch or replace fire protection materials to maintain integrity of fire ratings.
   2. Seal openings and joints in fire-rated assemblies per Div. 07 Section "FIRESTOPPING."

3.03 CLEANING

A. Remove debris and abandoned items from areas of work and from concealed spaces.

3.04 DISPOSAL OF WASTE

A. Comply with requirements in Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."

END OF SECTION 01 35 16
SECTION 01 35 43.13 - ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes special procedures for handling hazardous materials.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Div. 00 Document "EXISTING HAZARDOUS MATERIAL INFORMATION" for hazardous material investigation report information.

1.02 REGULATORY REQUIREMENTS

A. Comply with applicable laws, codes and regulations when hazardous materials are discovered.

1.03 REFERENCES

A. Definitions:
   1. Hazardous Materials: Any item or agent (biological, chemical, radiological, and/or physical), which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Refer to regulations administered by the U.S. Environmental Protection Agency (EPA), the U.S. Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), and the U.S. Nuclear Regulatory Commission (NRC).

1.04 INFORMATIONAL SUBMITTALS

A. Predemolition Photographs or Video: Submit before Work begins.

1.05 CLOSEOUT SUBMITTALS

A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.06 FIELD CONDITIONS

A. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
      a. In the case of asbestos, stop work in the area of potential hazard, shut off fans and other air handlers ventilating the area, and rope off area until the questionable material is identified. Reassign workers to continue work in unaffected areas. Resume work in the area of concern after safe working conditions are verified.
PART 2 - PRODUCTS

2.01 MATERIALS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that known hazardous materials have been remediated before proceeding with Work.

3.02 CLEANING

A. Containerize hazardous waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

END OF SECTION 01 35 43.13
SECTION 01 35 75 - DELEGATED DESIGN REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes provisions for assigning (delegating) design of certain building components to the Contractor.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Div. 02-49 Sections specify components of the Work for which design requirements are delegated to the Contractor.

1.02 DEFINITIONS

A. Delegated Design Work: Design services specifically assigned to Contractor to be completed by a qualified design professional retained by the Contractor for certain ancillary building components or systems required for the Work to satisfy design and performance criteria established by the Contract Documents.
   1. Delegated Design does not include professional services the Contractor needs to fulfill its responsibilities under the Contract including, but not limited to, construction means, methods and sequence.

B. Delegated Design Documents: Documentation necessary to show complete scope of delegated design work, prepared by or under the direct supervision and control of the design professional responsible for the subject work.

C. Engineering Services: Those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

D. Building Components: Includes, but is not limited to, systems, assemblies, manufactured units, equipment, mixes, and materials.

E. Deferred Submittal Items: Those portions of the design that are not submitted by the Architect at the time of the building permit application and that are to be submitted to the building official after construction begins but prior to installation of affected work.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Contractor Responsibilities: Provide professional design and engineering services, including certifications, when delegated design work is specified.
   1. Engage a qualified design professional to design designated ancillary building components or systems using performance requirements and design criteria indicated.
   2. Prepare and submit documents for deferred submittal, signed and sealed by the qualified design professional, as required for approval by authorities having jurisdiction for each delegated design item. Submit in a timely manner to avoid delaying the Work.
   3. Except for field quality assurance testing specified to be performed by the Owner, provide laboratory and field tests to establish performance characteristics of delegated design work at no additional cost to the Owner.
   4. Verify necessary approval of authorities having jurisdiction has been obtained prior to fabrication or installation of delegated design work.
B. Architect's Responsibilities: Review and coordinate submittal documents prepared by Contractor's design professional and forward deferred submittals to authorities having jurisdiction for approval.

1. Architect's review of delegated design documents is only to verify the deferred design component is in general conformance and compatibility with the Contract Documents and the overall Project design intent and can be integrated into the Project. Neither Architect nor Architect's consultants will verify calculations are correct.

2. Architect's review shall neither lessen nor shift the responsibility from the Contractor or its subcontractors, to the Architect or the Owner or their consultants.

3. The Owner and the Architect shall be entitled to rely upon the adequacy, accuracy and completeness of the delegated design services provided as demonstrated by the seal and signature of the design professional providing the service.

1.04 SUBMITTALS, GENERAL

A. Process and transmit in accordance with Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Delegated-Design Documents: For building components indicated to comply with performance requirements and design criteria, include documents specified in individual Sections, signed and sealed by the qualified design professional responsible for their preparation:

1. Design Data: Include the following:
   a. Engineering Analysis Data: Written and graphic information, including, but not limited to, performance and design criteria and list of applicable codes and regulations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
   b. Show compliance with design and performance requirements.
   c. Calculations are not required unless specifically requested by Architect.
   d. Additional data sufficient to show the correctness of the documentation including compliance with building code in effect with state amendments, if any, and other regulations of authorities having jurisdiction.

2. Design Calculations: Include the following:
   a. Engineering calculations for structural forces and loads of building components applied to building structure and other construction.
   b. Show reactions associated with connections.

3. Shop Drawings: Include the following:
   a. Show component members, dimensions, connections, and materials used.
   b. Details, fabrication and assembly information.
   c. Indicate how building component is attached to the main structure.
   d. Demonstrate coordination with supporting work and other components to be integrated with delegated design work.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:

1. Delegated design certificate.
2. Other certifications as required by individual Sections of these Specifications.

B. Submit a list of entities the Contractor has or will engage to perform delegated design work. Include field of specialty with names and contact information for design professionals.
1.07 QUALITY ASSURANCE

A. Qualifications:
   1. Design Professional Qualifications: Professional engineer experienced in providing
design and engineering services of the kind indicated and who is licensed or registered in
jurisdiction in which Project is located who assumes responsibility for the following:
   a. Preparation of comprehensive engineering design and analysis data.
      1) Data may be based on testing and engineering analysis of manufacturer's
         standard units in assemblies similar to those indicated for this Project,
         unless otherwise indicated.
   b. Preparation of engineering calculations.
   c. Preparation of shop drawings and other submittals.
   d. Testing program development.
   e. Review and corroborate comments from Architect and other reviewers on
delegated-design submittals and address required changes in their design.

PART 2 - PRODUCTS

2.01 PERFORMANCE CRITERIA

A. Performance characteristics are indicated by criteria subject to verification by one or more
methods including preconstruction testing, field testing, and in-service performance.
   1. Do not modify intended performance characteristics, as judged solely by Architect, except
with Architect's approval. If modifications are proposed, submit comprehensive
explanatory data to Architect for review.

B. Comply with applicable provisions of referenced standards:

C. Where design of building components is delegated to the Contractor the Contract Documents
establish design and performance criteria the work must satisfy. Refer questions about required
criteria to the Architect.
   1. Drawings are diagrammatic and broadly indicate layout, features, and major components
required, but do not cover complete details of design and construction, and do not purport
to identify nor solve problems of thermal or structural movement, anchorage, or moisture
disposal. Requirements shown by details are intended to establish basic dimensions,
visible lines and profiles of members. Final resolution of details is delegated to the
Contractor.
   2. In addition to requirements shown or specified, comply with applicable provisions of
building code, trade association standards, and authorities having jurisdiction for design,
materials, fabrication, and installation of component parts.
   3. Include necessary modifications to meet specified requirements and maintain visual
design concepts.
   4. Design elements to accommodate expansion and contraction due to structural
movement, movement within system, movement between system and perimeter framing
components, dynamic loading and release of loads, and deflection of structural support
framing, without detriment to appearance or performance, without damage to system or
components, and without damage to building component.
   5. Design building components and provide clearances that will allow for installation
tolerances, and expansion and contraction of adjacent materials, and sealant
manufacturer's recommended joint design where required.
   6. Design assemblies to be free from vibration harmonics, rattles, and noise due to thermal
and structural movement, and wind pressure.
   7. Design attachments to accommodate anticipated movement with no possibility of
loosening, weakening, or fracturing connections between adjoining system components
or between system components and building structure.
8. Design anchors, fasteners and braces to be structurally stressed not more than 50% of allowable stress when maximum loads are applied.
9. Provide concealed fastening wherever possible.
10. Do not assume sealants, and interior finishes contribute to framing member strength, stiffness, or lateral stability.

D. Structural Performance Requirements: Provide building components, including anchorages, capable of withstanding, without failure, the effects of gravity and applied loads and stresses within limits and under conditions indicated determined according to applicable code requirements. If design loads are not indicated on Drawings, perform delegated design based on the following:
   1. Design Wind Loads: Provide building components capable of withstanding the effects of wind loads applicable to Project As indicated on Drawings.
   2. Snow Loads: Provide building components capable of withstanding the effects of snow loads, including drifting snow, determined according to ASCE 7, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures."
   4. Ice Loads: Provide building components capable of withstanding the effects of ice loads determined according to ASCE 7, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures."

E. Deflection Limit: Do not exceed limits specified. In no case shall deflection be sufficient to cause permanent set, cracking or other damage to the building component or assemblies adjacent to or connect to it.

F. Thermal Performance Requirements:
   1. Provide building components that allow for thermal movements and stresses resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
   2. Do not transmit thermal movement from product components to other building elements

2.02 DESIGN REQUIREMENTS

A. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

B. Complete design of building components, including but not limited to modifications to standard components, shall be considered within the design delegated by the Contract Documents and shall not be used as a basis for claims or modification to the Contract.

C. Exterior Cladding:
   1. Assemblies forming the exterior cladding and enclosure of the building shall function in concert with other components of the total building envelope to provide a contiguous, weather-tight, thermally efficient enclosure. Provide air-barrier, insulation, flashing and
other components appropriate for each assembly. At a minimum each assembly and the overall integrated exterior enclosure shall achieve the following.

a. Provide thermal efficiency by resisting heat loss and heat gain within the specified performance criteria.
b. Prevent migration of air through the assembly except as controlled by window and door apertures.
c. Effectively control and collect water within the assembly and drain it to the building exterior.
d. Provide for control of water regardless of the source, whether due to environmental conditions, condensation, migration of water from other assemblies or other sources.
e. Integrate water control features within each cladding assembly and with other types of cladding to establish an effective, contiguous system throughout the exterior envelope of the building.

2. Coordinate cladding assemblies with supporting building structure and attachments to accommodate deviations due to the combination of allowed fabrication and erection tolerances. Identify and accommodate interferences resulting from the maximum tolerance range on shop drawings for the system.

a. Accommodate standard industry dimensional tolerances for building frame and other adjacent construction and comply with specified tolerance where they are more restrictive.

PART 3 - EXECUTION

3.01 SCHEDULE

A. The following Sections specify components of the Work for which design requirements are delegated to the Contractor.

1. 07 24 23.00 Direct-Applied Finish Systems
2. 07 42 13.13 Formed Metal Wall Panels
3. 07 42 13.19 Insulated Metal Wall Panels
4. 07 42 13.23 Metal Composite Material Wall Panels
5. 07 62 00 Flashing And Sheet Metal
6. 07 81 00 Applied Fireproofing
7. 07 84 00 Firestopping
8. 08 13 16 Aluminum Doors
9. 08 41 13.16 Fire-Rated Glazed Framing And Door Assemblies
10. 08 43 13 Aluminum-Framed Storefronts
11. 08 44 13 Glazed Aluminum Curtain Walls
12. 08 80 00 Glazing
13. 08 91 19 Fixed Louvers
14. 09 22 16 Non-Structural Metal Framing
15. 10 14 00 Signage

B. In addition to requirements for seismic bracing of mechanical, plumbing, electrical, and similar items, design and provide seismic bracing and otherwise secure items subject to displacement, movement and over-turning due to seismic forces which could create a life safety hazard either by direct injury or indirectly by blocking exit paths or creating other hazards. Such items include, but are not limited to, the following.

1. Architectural woodwork, casework, and similar items mounted to walls and weighing more than 20 pounds.
2. Free standing and supported architectural woodwork, shelving, casework, and similar items taller than 6 feet.
3. Appliances such as refrigerators, freezer and countertop items.
SECTION 01 56 39 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes protection and pruning of existing trees and plants that are affected by execution of the Work.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
   2. Div. 31 Section "SITE CLEARING" for removing trees and shrubs not indicated to remain.

1.02 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.

B. Plant-Protection Zone: Area surrounding vegetation to be protected during construction, and indicated on Drawings.

C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a concentric circle around each tree with a radius 1.5 times the diameter of the drip line, unless otherwise indicated.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Review enforcing requirements for protection zones.
   2. Review Arborist's responsibilities.

B. Tree Pruning Schedule: Prepare a written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
   1. Species and size of tree.
   2. Location on site plan. Include unique identifier for each.
   3. Reason for pruning.
   4. Description of pruning to be performed.
   5. Description of maintenance following pruning.

1.04 ACTION SUBMITTALS

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

B. Samples:
   2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

C. Tree Pruning Schedule.

1.05 INFORMATION SUBMITTALS

A. Arborist's certificate of compliance. Include listing conditions detrimental to tree and plant protection.

B. Preconstruction Photographs or Video: Submit before Work begins. Include photos or video of preexisting conditions, including adjoining construction and site improvements, that might be misconstrued as damage caused by construction work.
   1. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Qualification Statements for arborist and tree service firm.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

1.07 QUALITY ASSURANCE

A. Arborist Qualifications: Licensed arborist in jurisdiction where Project is located.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Certification: Arborist's certification that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

1.08 FIELD CONDITIONS

A. Prohibit the following practices in protection zones:
   1. Vehicular and foot traffic.
   2. Storage of construction materials, debris, or excavated material.
   3. Parking vehicles or equipment.
   4. Directing vehicle or equipment exhaust toward protection zones.
   5. Erection of sheds or structures.
   6. Heat sources, flames, ignition sources, and smoking near organic mulch.
   7. Impoundment of water.
   8. Excavation or other digging unless otherwise indicated.
   9. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

1.09 WARRANTY

A. Standard Warranty: Furnish Contractor's warranty agreeing to repair or replace vegetation that dies or exhibits unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   1. Warranty Periods:
TEMPORARY TREE AND PLANT PROTECTION

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
c. Annuals: 3 months.

2. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace, unless planting is required in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.01 MATERIALS

   A. Topsoil: Complying with ASTM D 5268.

   B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
      1. Type: Shredded hardwood.
      2. Size Range: 3 inches maximum, 1/2 inch minimum.

   C. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements. Previously used materials may be used when approved by Architect.
      1. Plastic Fencing: High_visibility orange, nonfading plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 to plus 200 deg F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet apart.
         a. Height: 4 feet.
      2. Gates: Access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; width as required for maintenance equipment and personnel.

   D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:
      1. Size: Approximately 18 inch high by 24 inch wide.
      2. Text and Lettering: As indicated below; white characters on red background, black characters on white background.

![](image)
TEMPORARY TREE AND PLANT PROTECTION

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Locate and clearly identify trees, shrubs, and other vegetation by tying 1-inch vinyl tape around each tree trunk at 54 inches above the ground, color-coded as follows:
   1. Items to Remain: Blue.
   2. Items to be Relocated: Yellow.
   3. Items to be Removed: Red.

C. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

D. Tree-Protection Zones: Mulch non-grass areas inside tree-protection zones and other areas indicated.
   1. Apply 4-inch average thickness of organic mulch. Do not place mulch within 6 inches of tree trunks. Do not place mulch around low-plantings.

3.02 TREE- AND PLANT-PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
   1. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
   2. Access Gates: Install where indicated or, if not indicated, where required for convenient access. Adjust hinged gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install signs spaced approximately every 25 feet to 50 feet on protection-zone fencing, with no less than one sign visible from each different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
   1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone unless preapproved in writing.
   2. Temporary access may be permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.
3.03 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Div. 31 Section "EARTH MOVING."

B. Trenching near Trees: Where utility trenches cannot be routed around protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.04 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings and as follows:
   1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
   2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
   3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   4. Cover exposed roots with burlap and water regularly.
   5. Backfill as soon as possible according to requirements in Div. 31 Section "EARTH MOVING."

B. Root Pruning at Edge of Protection Zone: Prune roots 6 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: When construction excavation within tree- or plant-protection zone is unavoidable, clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.05 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
   1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
   2. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
   3. Cut branches with sharp pruning instruments; do not break or chop.
   4. Do not apply pruning paint to wounds.
3.06 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
   1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.07 FIELD QUALITY CONTROL

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

3.08 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
   1. Submit details of proposed root cutting and tree and shrub repairs.
   2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
   3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
   4. Perform repairs within 24 hours.
   5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
   1. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches or smaller in caliper size.
   2. Provide one new tree of 6-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.
      a. Species: Species selected by Architect.
   3. Plant and maintain new trees as specified in Div. 32 Section "PLANTS."

C. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.
3.09 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 01 56 39
SECTION 01 75 00 - STARTING AND ADJUSTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general administrative and procedural requirements for starting and adjusting operating products, systems and equipment.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.

1.02 QUALITY ASSURANCE

A. Start-Up Personnel Qualifications: Factory-authorized service representative, equipment manufacturer's representative, or installer authorized in writing by equipment manufacture to perform startup procedures.
   1. When specified in individual specification Sections, require manufacturer to provide factory-authorized service representative to be present at site to inspect, check, and approve equipment or system installation prior to startup, and to supervise placing equipment or system in operation.

1.03 STARTING OF SYSTEMS

A. Notify Owner and Architect at least 7 days prior to startup of each system or piece of equipment.

B. Prior to beginning startup verify that:
   1. Equipment is free of latent manufacturing and installation defects.
   2. Lubrication has been performed.
   3. Drive rotation, belt tension, control sequences, tests, meter readings, and electrical characteristics are within manufacturer's requirements.
   4. Utility connections and support components are complete and tested.

C. Perform start-up under supervision of qualified personnel in accordance with manufacturers' instructions.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Perform functional field tests test to verify that the system and components have been properly installed and are functioning properly.

1.04 ADJUSTING

A. Adjust operable and moving parts to ensure smooth and unhindered operation.

B. Perform final lubrication as recommended by manufacturer.

C. Repair or replace units which cannot be adjusted to operate properly as intended for the application.

D. Repair, replace, or restore previously installed work damaged by work of individual Specification Sections to original condition. Obtain approval of the Architect and Owner for repaired work.
E. Final Adjustment: Wherever installation and startup is completed more than one month prior to Substantial Completion, return to the work during the week prior to Substantial Completion acceptance or occupancy, and make final check and adjustment of operable items.
   1. Clean operating items as necessary to restore proper function and finish.
   2. Make necessary adjustments to compensate for final operation of heating and ventilating equipment.

F. Occupancy Adjustments: When specified in individual specification Sections, return to the work within one year from date of Substantial Completion and prior to the end of the correction period.
   1. Provide on-site assistance in adjusting system to suit actual occupied conditions.

G. Submit written report that equipment or system has been properly installed and is functioning correctly.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 75 00
SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 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. "CLOSEOUT PROCEDURES".
   4. Spare parts and extra stock materials.
   5. Final cleaning.
   6. Starting and adjusting.
   7. Repair of the Work.

1.02 ACTION SUBMITTALS

A. Construction Manager's List of Incomplete Items: Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at final completion.

1.03 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

D. Maintenance Material Submittals: Furnish maintenance materials packaged with protective covering for storage and identified with labels describing contents and including model numbers and other identifying information as applicable. Ensure spare parts and extra stock materials match products installed. Obtain from same product runs and color batches as installed products. Deliver to Project site in location as directed; obtain receipt prior to final payment.
   1. Schedule: Prepare and submit schedule of spare parts, extra stock materials and maintenance material items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.
   2. Time of Submittal: Unless otherwise specified in individual Specification Sections, furnish spare parts and extra stock materials upon completion of associated work, but not less than 10 days prior to requesting inspection for determining date of Substantial Completion.
   5. Tools: Furnish a complete set of specialized tools for Owner's continued adjustment, maintenance, and removal and replacement of each different or special component furnished
      a. Provide maintenance tools supplied by product manufacturer.
      b. Label body of tools with identifying tool name and purpose.
CLOSEOUT PROCEDURES

1.04 SUBSTANTIAL COMPLETION PROCEDURES

E. Construction Manager's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Construction Manager's punch list), indicating the value of each item on the list and reasons why the Work is incomplete. Submit list prior to Architect Inspection.

F. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request. Submit closeout documents for Architect's records. Architect will not review closeout submittals. Submit Certificate of Release, Certificate of Insurance, Mechanical Equipment Operations and Maintenance Manuals, and Field Report for Pest Control Inspection for Architect's records per the Submittal Procedures. All other closeout submittals shall be sent directly to the Owner.
   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 Div. 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
   3. Submit closeout submittals specified in individual Sections, including specific "CLOSEOUT PROCEDURES", workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Submit maintenance material (attic stock) submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. 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.
   5. Submit testing, adjusting, and balancing records.
   6. Submit sustainable design submittals not previously submitted.
   7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

G. Procedures Prior to Substantial Completion: Complete the following a minimum of 15 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Advise Owner of pending insurance changeover requirements.
   2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   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.
   6. Advise Owner of changeover in utility services.
   7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
   8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   9. Complete final cleaning requirements.
  10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

H. Architect Inspection: Submit a written request for Architect Inspection to determine Substantial Completion a minimum of 15 working days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection
1.04 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 Div. 01 Section "PAYMENT PROCEDURES."
   2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   4. Submit pest-control final inspection report.
   5. Submit final completion photographic documentation.

B. Architect Final Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 working days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Construction Manager of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Construction Manager of construction that must be completed or corrected before certificate will be issued.
   1. If required, request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
      a. Architect will complete one Inspection and one Final Inspection (Back Punch). Reinspection will be made only with the consent of the Owner after notification by the Architect.
      b. Construction Manager shall reimburse Owner for Architect’s account for time spent in additional reinspection(s) at the hourly billing rate.
      c. Cost will be deducted from Construction Manager's retention as a deduct Change Order.

1.05 LIST OF INCOMPLETE ITEMS (CONSTRUCTION MANAGER’S 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 Construction Manager that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect.
      d. Name of Construction Manager.
      e. Page number.
1.06 SUBMITTAL OF PROJECT "CLOSEOUT PROCEDURES"

A. Time of Submittal: Submit written "CLOSEOUT PROCEDURES" on request of Architect for designated portions of the Work where "CLOSEOUT PROCEDURES" are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of "CLOSEOUT PROCEDURES" might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranty Electronic File: Provide "CLOSEOUT PROCEDURES" 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.

D. Provide additional copies of each warranty to include in operation and maintenance manuals to Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 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.
   4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Immediately upon completion of installation of products, clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended.

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. 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.

H. 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.

I. Waste Disposal: See Division 01 Section "Construction Waste Management and Disposal."

3.02 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 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 project sustainability requirements and requirements defined in Div. 23. Provide written report on completion of cleaning.
CLOSEOUT PROCEDURES

C. Pest Control: Comply with pest control requirements in Div. 01 Section "TEMPORARY FACILITIES AND CONTROLS." Prepare written report.

D. Construction Waste Disposal: Comply with waste disposal requirements in Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."

3.03 STARTING AND ADJUSTING

A. Starting of Systems:
   1. Prior to beginning startup verify that:
      a. Equipment is free of latent manufacturing and installation defects.
      b. Lubrication has been performed.
      c. Drive rotation, belt tension, control sequences, tests, meter readings, and electrical characteristics are within manufacturer's requirements.
      d. Utility connections and support components are complete and tested.
   2. Perform start-up under supervision of qualified personnel in accordance with manufacturers' instructions.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Perform functional field tests test to verify that the system and components have been properly installed and are functioning properly.

B. Adjusting:
   1. Adjust operable and moving parts to ensure smooth and unhindered operation.
   2. Perform final lubrication as recommended by manufacturer.
   3. Repair or replace units which cannot be adjusted to operate properly as intended for the application.
   4. Final Adjustment: Wherever installation and startup is completed more than one month prior to Substantial Completion, return to the work during the week prior to Substantial Completion acceptance or occupancy, and make final check and adjustment of operable items.
   5. Occupancy Adjustments: When specified in individual specification Sections, return to the work within one year from date of Substantial Completion and prior to the end of the correction period.
   6. Submit written report that equipment or system has been properly installed and is functioning correctly.

C. Protecting Installed Construction:
   1. Institute protective measures and other precautions required to assure that installed products will be without damage or deterioration, other than normal weathering, at time of Substantial Completion.
   2. Comply with manufacturer's written instructions for temperature and relative humidity.
   3. If, despite protection, damage or deterioration occurs, cut out and remove damaged and deteriorated products and replace with new materials to produce installations with repaired areas indistinguishable from original work.
      a. Engage original installer to repair or replace deteriorated or defective work found at time of final inspection to the Architect's satisfaction. Repair damage which occurred subsequent to installation and prior to final inspection at no cost to the Owner. Restore the Work to a condition free of damage and deterioration at time of Substantial Completion.
CLOSEOUT PROCEDURES

3.04 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 01 77 00
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SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general administrative and procedural requirements for processing operation and maintenance data manuals for products and equipment.

B. Related Requirements:
   1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.

1.02 CLOSEOUT SUBMITTALS

A. Where specified in individual Specification Sections, submit operation and maintenance (O&M) data for provided equipment, products, and systems.
   1. Required content is specified in individual Specification Sections.
   2. Initial Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training.
      a. Submittal Format: Submit or post files in Portable Data File (PDF) format. Architect will mark any required revisions.
   3. Revise content of manuals as required prior to final submittal.
   4. Final Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training.
      a. Submittal Format: Submit or post files in Portable Data File (PDF) format within 10 days after final inspection.

B. Electronic Document Files:
   1. Enable bookmarking of 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.

1.03 OPERATION AND MAINTENANCE DATA

A. Prepare O&M Data for provided equipment, product, or system, defining the importance of system interactions, troubleshooting, and long-term preventive operation and maintenance. Compile, prepare, and aggregate O&M data to include clarifying and updating the original sequences of operation to as-built conditions.
   1. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level.
   2. Bookmark and arrange each submittal by system and subdivide by Specification Section using current version of CSI MasterFormat numbering system
   3. Each manual shall contain:
      a. Project Information: List names, addresses, and telephone numbers of Owner, Architect, and Contractor. For each product and equipment category, identify names, addresses, and telephone numbers of installing subcontractors and suppliers. Include names, addresses, and telephone numbers of major consultants to the Architect that designed the systems contained in the manuals.
      b. Table of Contents and Index.
c. Cross-reference to related systems in other O&M manuals.

B. Contents required in O&M data packages as applicable to system:
   1. Directory: Prepare a single, comprehensive directory listing and identifying each category of product, finish, equipment, and system included.
      a. List systems and subsystems alphabetical and by CSI MasterFormat number.
      b. List equipment for each system alphabetical and by CSI MasterFormat number.
      c. Identify each system, subsystem, and piece of equipment with a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."
   2. Operating instructions.
      a. Significant design criteria.
      b. Description and diagrams for operating hardware.
      c. Description and operating characteristics for motor operators.
      d. Safety precautions and hazards.
      e. Operator prestart.
      f. Startup, break-in, shutdown, and post-shutdown procedures. Include seasonal and weekend operating procedures.
      g. Normal operations.
      h. Required sequences for electric or electronic systems.
      i. Emergency operations by type of emergency.
      j. Operator service requirements.
      k. Environmental conditions.
      l. Operating log.
   3. Preventive maintenance for equipment and systems.
      a. Lubrication data.
      b. Preventive maintenance plan, schedule, and procedures.
      c. Cleaning recommendations.
   4. Repair.
      a. Troubleshooting guides and diagnostic techniques.
      b. Piped system diagrams.
      c. Wiring diagrams and control diagrams, including changes made in final work.
      d. Repair procedures.
      e. Removal and replacement instructions.
      f. Spare parts and supply lists.
   5. Maintenance instructions for architectural and special finishes and fabrics.
      a. Methods for maintaining fabrics and finishes.
      b. Cleaning recommendations including recommended cleaning materials.
      c. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
      d. Safety precautions and hazards.
   6. Appendices: Provide information below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:
      a. Copies of submittals for each product in manual marked as reviewed and "Approved" or "Approved as Noted" or other similar terms and used for construction.
      b. Manufacturer's instructions.
      c. Testing and performance data including HVAC balance reports.
      d. Certificates.
      e. Copies of "CLOSEOUT PROCEDURES" and bonds.
      f. Personnel training requirements.
      g. License requirements including inspection and renewal dates.
      h. Testing equipment and special tool information.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 78 23
SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general administrative and procedural requirements for processing Project Record Documents including:
1. Record Drawings.
2. Record Submittals.

B. Related Requirements:
1. Requirements of this Section apply to, and are a component part of, each Section of the Specifications.
2. Div. 01 Section "CLOSEOUT PROCEDURES" for general closeout procedures.
3. Div. 01 Section "OPERATION AND MAINTENANCE DATA" for operation and maintenance manual requirements.
4. Div. 01 Section "CLOSEOUT PROCEDURES" for warranty manual requirements.

1.02 DEFINITIONS

A. Record Documents: Contractor-maintained copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications marked as Work progresses to indicate field changes and selections made during construction.

1.03 CLOSEOUT SUBMITTALS

A. Preparation: Identify and date each Record Document; include the designation "PROJECT RECORD DOCUMENT" in a prominent location.
1. Paper Documents: Bind into manageable sets or volumes, each with durable, tear-resistant cover and backing sheets with reinforced binding margin.
2. Electronic PDF Files: Enable bookmarking of individual documents based on file names. Ensure comment function is enabled.
3. Label each set or volume on cover sheets with one of the following titles as appropriate. When more than one set or volume is required, identify by set or volume number with brief indication of volume contents (e.g. "Set 1 of 3 - Architectural Drawings" or "Volume 3 of 3 - MEP Specifications").
   a. "PROJECT RECORD DRAWINGS"
   b. "PROJECT RECORD SUBMITTALS"
4. Include the following additional identification on cover sheet:
   a. Project name.
   b. Date.
   c. Index of included documents.
   d. Name of Architect.
   e. Name of Contractor.
5. Submittal: Submit required Record Documents in final form at least 5 days before to requesting inspection for Substantial Completion.

B. Submit in formats as follows:
1. Record Drawings: Each of the following formats:
   a. Record Prints: Original marked paper prints.
   b. As scanned PDF of original marked paper prints.
   c. Include newly prepared Record Drawings, if any.
2. Record Submittals:
PART 2 - PRODUCTS

2.01 RECORD DRAWINGS.

A. Record Prints: Maintain one set of marked-up paper copies of the Contract 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 archive photographic documentation.

2. Types of items requiring marking include, but are not limited to, the following:
   a. Field changes of dimension and detail.
   b. Revisions to details shown on Drawings.
   c. Details not on original Drawings.
   d. Measured depths of foundations in relation to finish floor datum.
   e. Measured locations and depths of underground utilities and appurtenances, referenced to permanent surface improvements.
   f. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   g. Revisions to routing of piping and conduits.
   h. Revisions to electrical circuitry.
   i. Actual equipment locations.
   j. Duct size and routing.
   k. Changes made to original Drawings. Note change type (e.g. Alternate, Construction Change Directive, Change Order, Supplemental Instruction, and similar identification) and number where applicable.
   l. Record information on the Work that is shown only schematically.
   m. Mark additional important information that was either shown schematically or omitted from original Drawings.

3. Mark Record Prints completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints. Use erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

4. Organize contents according to original Drawings.

B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.

2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly
2.02 RECORD SUBMITTALS

A. General: Include only Submittals marked as reviewed and "Approved" or "Approved as Noted" or other similar terms and were used for construction. Do not include submittals that were marked "Revise and Resubmit" or "Rejected" or other similar terms.
   1. Organize contents according to Project Manual Table of Contents.
   2. Note significant changes in products delivered to Project site and changes in manufacturer's written instructions for installation.
   3. Note changes made to original Contract Documents. Note change type (e.g. Alternate, Construction Change Directive, Change Order, Supplemental Instruction, and similar identification) and number where applicable.
   4. Mark any changes to Submittals completely and accurately in a manner to clearly differentiate markings made after review and release for use in construction.

B. Record Product Data: Mark each data sheet to record actual product installed including options, colors, and other selections.

C. Record Shop Drawings: Mark each drawing to record actual construction including field changes of dimension and detail and details not on original Shop Drawings.

D. Record Samples: Mark each sample to record actual product installed including colors, options and other selections. Retain only samples of materials used in the work. Discard samples not installed if loose samples were submitted (i.e. laminate sample chains).
   1. Immediately before date of Substantial Completion, meet with Architect and Owner's personnel at Project site to determine which Samples maintained during the construction period shall be transmitted to Owner for record purposes.
   2. Comply with Architect's instructions for packaging, identification marking, and delivery to Owner's Sample storage space. Dispose of other Samples in the manner specified for disposing surplus and waste materials.

2.03 MISCELLANEOUS RECORD SUBMITTALS

A. Miscellaneous Submittals: Mark each item to record changes required during construction.
   1. Assemble miscellaneous submittals 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.
   2. Organize contents according to Project Manual Table of Contents.

PART 3 - EXECUTION

3.01 MAINTENANCE, STORAGE, AND REVISIONS

A. Store Record Documents on site during construction; Store Record Documents separate from documents used for construction. Do not use project record documents for construction purposes.

B. Record changes and revisions to Record Documents concurrent with construction progress. Do not wait until end of Project. Make entries neatly and accurately.
C. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Record Documents for Architect's reference during normal working hours.

1. Accurately record information in an acceptable drawing technique using personnel proficient at recording graphic information.

2. Record data as soon as possible after obtaining it.

3. 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.

4. Record and check markup before enclosing concealed installations.

END OF SECTION 01 78 39
SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Commissioning objectives are to provide documented confirmation that each facility fulfills the functional and performance requirements of the building owner, occupants, and operators.

B. The general commissioning specification provides the general outline for commissioning requirements and supports other sections included below:
   1. Division 20 Section 20 08 00 Mechanical Commissioning Requirements
   2. Division 26 Electrical Commissioning Requirements

1.3 SCOPE OF COMMISSIONING

A. The following systems are to be commissioned:
   1. Central building automation system
   2. Heating, ventilating and air conditioning equipment and systems
   3. Electrical equipment and systems

B. Commissioning during design is intended to achieve the following specific objectives:
   1. Provide an operation and maintenance focused Design Review during AE design efforts.
   2. Verify commissioning for the construction phase is adequately reflected in the bid documents.

C. Commissioning during the construction phase of this project is intended to achieve the following specific objectives:
   1. Provide direction for the commissioning process during construction, particularly providing resolution to issues and providing details not developed during design (ex. scheduling, participation of various parties, lines of reporting and approvals, coordination, etc.)
   2. Verify that applicable equipment and systems are installed properly and receive adequate operational checkout by installing contractors.
   3. Verify and document proper performance of equipment and systems.
   4. Verify that O&M documentation left on site is complete.
   5. Verify that the Owner’s operating personnel are adequately trained.

D. The Commissioning process does not take away from or reduce the responsibility of the system designers to design a workable system nor the installing contractors to provide a finished and fully functioning product.

1.4 DEFINITIONS
A. Acceptance: A formal action, to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Acceptance Phase: Phase of commissioning after start-up and initial checkout when functional performance tests, O&M documentation review and training occurs.

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

D. Commissioning Authority (CxA): An entity identified by the Owner who plans, schedules and coordinates the commissioning team to implement the Commissioning Process.

E. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the Owner’s Project Requirements).

F. Functional Performance Test: The testing of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, etc. The systems are run through all the control system’s sequence of operation and components are verified to be responding as the sequences state. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor.

G. Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of a project or other scheduling issues, in order to minimize the total construction time.

H. Seasonal Performance Test: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

I. Startup: The initial starting or activating of dynamic equipment, including completing construction checklists.

J. Systems Manual: A systems focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase.

K. Test Procedures: The step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CxA.

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

M. Trending: Monitoring over a period of time.

N. Warranty Period: Warranty period for the entire project, including equipment components. Warranty begins at Substantial Completion and extends typically for at least one year, unless specifically noted otherwise in the Contract Documents.

1.5 DOCUMENTATION

A. The CxA oversees and maintains the development of commissioning documentation. These documents include the following:

1. Commissioning Specifications
2. Commissioning Plan
3. Construction Checklists, to be filled in by the installing contractor
4. Functional Testing Scripts, performed by the contractor and witnessed by the CxA
5. Corrective action document
6. Final Commissioning Report
7. Systems Manual
8. Warranty Review Report
B. The construction manager and contractor to provide the following documentation to the CxA for their review:

1. Equipment Submittals, which shall include the following information:
   i. Manufacturer's product data, cut sheets, and shop drawings.
   ii. Manufacturer's installation instructions.
   iii. Startup, operating, and troubleshooting procedures.
   iv. Fan and pump curves.
   v. Factory test reports.
   vi. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.
2. Operations and Maintenance Manuals
3. Test and inspection reports and certificates
4. Filled in and completed Construction Checklists, provided by the CxA
5. Training Agendas and associated documentation

1.6 COORDINATION

A. Commissioning Kick-Off Meeting – Construction Team: Contractors will attend a meeting of the Commissioning Team, chaired by the CxA, to review the scope of commissioning process activities and the Commissioning Plan with discussions on milestones, activities, and assignments of responsibilities.

B. Commissioning Meetings: Contractors will attend coordination meetings with the Commissioning Team, chaired by the CxA, to review progress on the Commissioning Plan, construction deficiencies, scheduling conflicts, and to discuss strategies and processes for upcoming commissioning process activities.

C. Miscellaneous Construction Meetings: The CxA attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in the commissioning process.

D. Pre-testing Meetings: Contractors will attend pretest meetings with the Commissioning Team, chaired by the CxA, to review startup reports, pre-test inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers’ authorized service representative services for each system, subsystem, equipment, and component to be tested.

E. Testing: Contractors will coordinate with testing personnel and agencies for timing and access for CxA to witness test.

F. Manufacturers’ Inspection and Startup Services: Contractors will coordinate services of manufacturers’ inspection and startup services.

G. Testing, Adjusting and Balancing: Contractors will coordinate with plan and schedule for testing, adjusting and balancing for timing and access for CxA to witness process.

H. Contractors will coordinate all training dates and agendas with the CxA

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard
testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from the vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Temporary data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of ±0.1°F. Pressure sensors shall have an accuracy of ±0.2% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 EXECUTION

3.1 COMMISSIONING PLAN

A. The CxA shall provide the Owner with a written Commissioning Plan that is based on the Owner’s Project Requirements and the Basis of Design. The Commissioning Plan shall describe commissioning activities for the Project and identify documentation requirements of the commissioning process. The CxA shall update the Commissioning Plan periodically as appropriate to the level of completeness of the design and the progress of construction. The Owner shall approve the final Commissioning Plan. The Commissioning Plan shall include but not be limited to:

1. Identification of the Owner’s Project Requirements and the portions of the Basis of Design used as the basis of the Commissioning Plan
2. A list of participants in the commissioning process, their roles and responsibilities, and protocols for participant communication and information distribution
3. A list of systems and assemblies to be commissioned and performance expectations for each
4. A description of commissioning activities and responsibility for each
5. A summary of commissioning related documentation required by governmental authorities or entities certifying the Project.
6. The Schedule of Commissioning Services
7. Protocols for commissioning design reviews
8. Protocols for commissioning submittal reviews
9. Protocols to document changes to the Owner’s Project Requirements and Basis of Design
10. Protocols and templates for commissioning related documentation, including the Issues Log, Construction Checklists, Functional Performance Test procedures and reports, the Systems Manual, and the operator training plan
11. Identification of, and protocols for, documents to be provided by the Owner’s contractors, such as start-up reports, systems readiness test reports, test and balance plans and reports, and quality control test documents
12. Protocols for the Consultant to report observed deficiencies that pertain to the systems and assemblies to be commissioned.
3.2 DESIGN PHASE COORDINATION MEETING

A. The CxA shall conduct and document a design phase coordination meeting with the Owner and other participants in the commissioning process to discuss and review the Owner’s Project Requirements and the Commissioning Plan. The CxA shall conduct and document additional design phase coordination meetings as necessary.

3.3 COMMISSIONING DESIGN REVIEWS

A. The CxA shall periodically review the designs prepared by the Owner’s consultants and contractors for the systems and assemblies to be commissioned. The CxA review shall be for the limited purpose of checking for conformance with information given and concepts expressed in the Owner’s Project Requirements and the Basis of Design. The CxA shall be entitled to rely upon, and shall not be responsible for, the adequacy and accuracy of the designs prepared by the Owner’s consultants and contractors. However, if the CxA becomes aware of any inadequacy or inaccuracy of the designs, the CxA shall provide the Owner and Owner’s Representative with prompt written notice. The CxA commissioning design reviews shall be made with reasonable promptness and in accordance with the Commissioning Plan and Schedule of Commissioning Services. Upon completion of each review, the CxA shall issue written comments and recommendations in accordance with the Commissioning Plan. At each subsequent review and after the final review, the CxA shall document the resolution of comments from the previous reviews.

B. The CxA will review the following Drawing Sets

1. 100% Design Development
2. 90% Construction Drawings

3.4 COMMISSIONING SPECIFICATIONS

A. The CxA shall prepare Commissioning Specifications that define the general commissioning requirements of the Project and commissioning requirements for each system and assembly to be commissioned. The Commissioning Specifications shall include requirements for Construction Checklist development and execution, startup procedures, Functional Performance Tests and acceptance criteria, and operator training. If necessary, the CxA shall coordinate with the Owner’s other consultants to integrate commissioning related requirements into specifications provided by others.

3.5 CONSTRUCTION PHASE COORDINATION MEETING

A. Prior to commencement of construction activities on systems and assemblies to be commissioned, the CxA shall conduct and document a construction phase coordination meeting with the Owner and other participants in the commissioning process to discuss and review the Commissioning Plan and Commissioning Specifications. The CxA shall conduct and document additional commissioning phase coordination meetings as necessary during construction.

3.6 SUBMITTAL REVIEW

A. The CxA shall review and provide written comments upon contractors’ submittals that pertain to the systems and assemblies to be commissioned, but only for the limited purpose of checking for conformance with the requirements of the Commissioning Plan and Commissioning Specifications. The Consultant’s action in reviewing submittals shall be taken in accordance with the approved submittal schedule, or in the absence of an approved schedule, with reasonable promptness while allowing sufficient time to permit adequate review. The CxA submittal review is not for the purpose of determining the accuracy and completeness of other information such as dimensions, quantities, and installation or performance of systems or assemblies, which are the
contractors’ responsibilities. The CxA review shall not constitute approval of safety precautions or any construction means, methods, techniques, sequences, or procedures.

3.7 CONSTRUCTION DOCUMENTATION REVIEW

A. During construction, the CxA shall review documentation related to the systems and assemblies to be commissioned such as meeting minutes, field reports, minor changes in the Work, Construction Change Directives, and Change Orders. In accordance with the Commissioning Plan, the CxA shall report issues it identifies during its reviews that may prevent the systems and assemblies from performing in accordance with the Commissioning Plan and Commissioning Specifications.

3.8 ISSUES LOG

A. The CxA shall consult with the Owner and other participants in the commissioning process regarding commissioning related issues that arise during the Construction Phase. The CxA shall maintain and update an Issues Log regarding such issues and their resolution in accordance with the protocols established in the Commissioning Plan.

3.9 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists for systems and assemblies to be commissioned that the Owner’s contractors can use to verify that materials and components are on site, ready for installation, correctly installed, and in compliance with the Commissioning Plan and Commissioning Specifications. The CxA shall distribute the Construction Checklists in accordance with the Commissioning Plan.

3.10 SITE VISITS

A. Unless otherwise stated in the Commissioning Plan, the CxA shall visit the site in the CxA professional judgement, as often as necessary, appropriate to the stage of construction to become generally familiar with the assembly, installation, and startup of systems and assemblies to be commissioned; however, the CxA shall not have control over, charge of, or responsibility for the assembly, installation, and startup of such systems and assemblies. In accordance with the Commissioning Plan, the CxA shall promptly report to the Owner, and Owner’s Representative (1) known deviations from the Commissioning Specifications and Commissioning Plan and (2) defects and deficiencies observed by the CxA.

3.11 TESTING REPORT REVIEWS

A. The CxA will verify completion of the following testing reports per the project scope and specifications:

1. HVAC pressure testing and flushing reports
2. Ductwork pressure testing and cleaning
3. Equipment Start Up Reports
4. Test and Balance Reports

3.12 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Tests evaluate the function and operation of systems and assemblies to be commissioned by observation or monitoring. Prior to the commencement of Functional Performance Tests, the CxA shall review start-up reports, systems readiness test reports, test and balance plans and reports, and quality control test documents, for systems and assemblies to
be commissioned, and report any observed deficiencies in accordance with the Commissioning Plan.

B. The CxA shall coordinate, observe, and document Functional Performance Tests for systems and assemblies to be commissioned, in accordance with the procedures set forth in the Commissioning Plan and Commissioning Specifications.

C. The CxA shall prepare written reports that summarize each Functional Performance Test. The CxA shall document deficiencies identified during Functional Performance Tests in the Issues Log. Each deficiency shall be resolved by the appropriate party and, thereafter the CxA shall direct, observe, and document re-testing to confirm that the deficiency has been corrected. The CxA shall distribute the Functional Performance Test reports in accordance with the Commissioning Plan.

D. For terminal heating and cooling devices, a minimum of 25% shall be verified for compliance with start up and operating procedures. If consistent deficiencies are discovered, additional devices may require verification by the CxA at the cost of the respective contractors.

3.13 DOCUMENTATION REVIEW

A. The CxA shall review operations and maintenance manuals, record documents, and warranties, for commissioned systems and assemblies, for conformance with the Commissioning Specifications. The CxA shall report observed deficiencies in accordance with the Commissioning Plan.

3.14 SYSTEMS MANUAL

A. Prior to the start of operator training and in accordance with the Commissioning Plan, the CxA shall provide the Owner with a Systems Manual that describes how to operate and maintain the commissioned systems and assemblies. The Systems Manual shall consist of documents provided by the Owner’s contractors and consultants, including operations and maintenance manuals, submittals, record drawings, specifications, certifications, and training documents.

3.15 OPERATOR TRAINING

A. The CxA shall review contractor-provided information regarding operator training, and the schedule of training activities, for conformance with specification requirements for systems and assemblies to be commissioned. The CxA shall report observed deficiencies to the Owner and Owner’s Representative in accordance with the Commissioning Plan.

B. The CxA shall maintain an operator training log for inclusion in the Commissioning Report. The operator training log will include the attendees’ names, training dates, system or equipment on which training was performed, and the name, title, and contact information of the trainer.

3.16 COMMISSIONING REPORT

A. The CxA shall prepare a Commissioning Report that summarizes the operation of the commissioned systems and assemblies and the Commissioning Services performed. The Commissioning Report shall include an executive summary, the Owner’s Project Requirements, Basis of Design, the final Commissioning Plan, Commissioning Specifications, design review comments and resolutions, system readiness test reports, completed Construction Checklists, template Functional Performance Test procedure forms, completed Functional Performance Test reports, the Issues Log, the operator training plan and log, a description of required deferred Functional Performance Tests, and recommendations for ongoing commissioning. The CxA shall distribute the Commissioning Report in accordance with the Commissioning Plan.

3.17 WARRANTY REVIEW
01 9113 - 8 GENERAL COMMISSIONING REQUIREMENTS

A. The CxA shall meet with the Owner prior to the expiration of the Owner’s contractors’ periods for warranty to review the operations and performance of the commissioned systems and assemblies. A warranty review report will be generated for the owner and construction team to address and correct any identified issues.

B. The CxA will return to the site at 11 months into the 24-month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning.

C. The CxA will also interview facility staff and identify problems or concerns they have with operating the building as originally intended.

END OF SECTION 01 91 13
SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes demolition of selected portions of site elements and building construction, equipment, and fixtures while protecting the remaining structure.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 REFERENCES

A. Definitions:
   1. 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.
   2. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
   3. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
   4. Remove and Reinstall: Detach items from existing construction, protect during storage, prepare for reuse, and reinstall where indicated.
   5. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
      a. Where permitted by Architect, items may be dismantled and moved to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
   6. Utilities: As used herein, includes systems for fire protection, plumbing, drainage, HVAC, integrated automation, electrical, communications, and electronic safety and security.

B. Reference Standards:
   1. Comply with governing EPA notification regulations before beginning demolition.
   3. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Review list of items indicated to be salvaged or reinstalled.

B. Schedule of Activities: Prepare a schedule for demolition activities showing the following
   1. Detailed sequence of demolition and removal by area. Show start and end dates for each activity.
   2. Indicate when and how long utilities will be interrupted.
   3. Timing for use of stairs.
1.04  SUBMITTALS, GENERAL
    A. Process and transmit in accordance with Div. 01 Section "SUBMITTAL PROCEDURES."

1.05  ACTION SUBMITTALS
    A. Shop Drawings showing the following:
       1. Storage location for items to be salvaged or reinstalled.
       2. Location and construction of temporary construction including barriers and enclosures.

1.06  INFORMATIONAL SUBMITTALS
    A. Predemolition Photographs or Video: Submit before Work begins. Include photos or video of
       existing conditions that might be misconstrued as damage caused by demolition work.
    B. Schedule of Activities: Submit before Work begins
    C. Qualification Statement for refrigerant recovery technician.

1.07  CLOSEOUT SUBMITTALS
    A. Inventory of items removed and salvaged.
    B. Landfill records indicating receipt and acceptance of hazardous wastes by a landfill facility
       licensed to accept hazardous wastes.
    C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician 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.
    D. Documentation verifying that repairs to existing, warranted products have been inspected and
       "CLOSEOUT PROCEDURES" remain in effect.

1.08  QUALITY ASSURANCE
    A. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a
       "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are
       trained in lead-safe work practices.
    B. Safety and Health Standard: Comply with ANSI/ASSE A10.6 "Safety & Health Program
       Requirements for Demolition Operations."
    C. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification
       program.

1.09  STORAGE AND HANDLING OF SALVAGED MATERIALS
    A. Salvaged Materials, General:
       1. Clean only loose dirt and debris from salvaged items unless more extensive cleaning is
          indicated.
       2. Pack or crate items after cleaning; cushion and protect against damage during handling,
          transport and storage. Catalog salvaged items and label contents of containers.
3. Identify each item with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.

4. Store items until delivery to Owner or until reinstallation.
   a. Store items in a weathertight enclosure protected from damage due to moisture, weather, condensation, and freezing temperatures.
   b. Secure against theft and vandalism.
   c. Maintain humidity in storage facility below 85 percent. Maintain temperatures at least 5 deg F above dew point.
   d. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

B. Salvaged Materials for Reinstallation:
   1. Repair and clean items for reuse as indicated and to functional condition for reuse. Repair operable items to function properly.
   2. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
   3. Do not use materials with objectionable chips, cracks, splits, dents, scratches, or other defects.

C. Salvaged Materials for Delivery to Owner:
   1. Owner will arrange for limited on-site location(s) for storage of salvaged material at no cost to Contractor. This storage space includes security for stored material.
   2. Transport items to Owner's designated on-site storage area. Owner will arrange for further transportation to off-site storage location, if required.

1.10 FIELD CONDITIONS

A. Refer to Div. 01 Section "WORK RESTRICTIONS" for Owner occupancy requirements.

B. Refer to Div. 01 Section "ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS."

C. Existing conditions will be maintained by Owner as far as practical.
   1. Owner will remove the following items Owner desires to retain before selective demolition begins:
      a. Furniture and furnishings.
      b. Equipment.

D. If any of the following conditions are encountered, cease work immediately, notify Architect and Owner, and await instructions:
   1. Structure is in danger of movement or collapse.
   2. Materials or existing conditions encountered differ from those designated in the Contract Documents.

E. Storage or sale of removed items on-site is not permitted.

1.11 WARRANTY

A. Existing "CLOSEOUT PROCEDURES": If products under warranty and indicated to remain are damaged by demolition activities, repair by means to maintain existing "CLOSEOUT PROCEDURES" in effect.
   1. Notify warrantor and obtain direction before proceeding with repairs.
2. Upon completion of repairs, request inspection by warrantor and obtain documentation verifying that repair work has been inspected and warranty remains in effect.

3. Existing "CLOSEOUT PROCEDURES" include the following:
   a. Roof system.

PART 2 - PRODUCTS

2.01 PERFORMANCE CRITERIA
   A. Comply with Div. 01 Section "TEMPORARY CONTROLS."

2.02 DESCRIPTION
   A. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning selective demolition work. Comply with hauling and disposal regulations of authorities having jurisdiction.

2.03 MATERIALS
   A. Floor Covering Adhesive Removal Agents:
      1. For carpet removal, comply with Carpet and Rug Institute "Carpet Installation Standard."

2.04 REMOVAL EQUIPMENT
   A. Size Limitations: When transporting debris, materials, and products in existing spaces, maintain not less than 12 inch clearance between materials, products, and equipment used for performing the Work and existing surfaces where possible. When required clearances are not feasible to maintain, provide adequate protection for existing surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION
   A. Comply with the following prior to commencement of operations:
      1. Div. 01 Section "EXAMINATION AND PREPARATION."
      2. Div. 01 Section "TEMPORARY BARRIERS AND ENCLOSURES" for temporary barriers, barricades, fencing, protective walkways, and security barriers and enclosures.
         a. Ensure safe passage of people around selective demolition area and to and from occupied portions of building.
      3. Div. 01 Section "TEMPORARY TREE AND PLANT PROTECTION" for temporary protection of trees and plants to remain including pruning.
      4. Div. 01 Section "TEMPORARY CONTROLS."

   B. Before beginning demolition work verify, in correspondence with Owner, that items Owner desires to retain have been removed:

   C. Survey existing conditions and correlate with requirements indicated. If discrepancies, unanticipated utilities or structural elements that conflict with intended function or design are discovered, notify Architect and request direction as to how to handle such items.
      1. Record existing conditions that affect the Work by use of measured drawings, preconstruction photographs, and preconstruction video recordings per Div. 01 Section "PHOTOGRAPHIC DOCUMENTATION."
2. Inventory and record the condition of items to be removed and salvaged or removed and reinstalled. If items indicated to be salvaged or reinstalled are damaged, notify Architect and request direction.

D. Perform an engineering survey of condition of building to determine if removing elements indicated might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures.
   1. Perform additional engineering surveys as the Work progresses.

3.02 PROTECTION

A. Provide shoring, bracing, and supports for construction designated to remain to preserve stability and prevent movement, settlement, or collapse of construction designated to remain.

B. Provide protective coverings for furniture, furnishings, and equipment that have not been removed.

C. Protect walls, ceilings, floors, and other existing finishes designated to remain against damage and soiling from construction work.

D. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
   1. Use only proven protection methods, appropriate to each area and surface being protected.
   2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
   3. Erect temporary barriers to form and maintain fire-egress routes.
   4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
   5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
   6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
   7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
   8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.

E. Temporary Protection of Materials to Remain:
   1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
   2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.

3.03 PROTECTION DURING APPLICATION OF CHEMICALS

A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.

B. Cover adjacent surfaces with protective materials that are proven to resist chemicals to be used unless chemicals being used pose no risk of damage as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. Promptly remove protective materials when no longer needed.
C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.

D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.

E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.04 MATERIALS OWNERSHIP

A. Notify Owner if historic items are encountered or uncovered during the Work, regardless of whether they were previously documented. Historic items include, but are not limited to, relics, antiques and similar objects, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner. Historic items remain Owner's property.

1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to Owner where directed at Project site.

3.05 UTILITY SERVICES AND SYSTEMS

A. Before commencing operations, notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling utilities services affected by demolition work. Comply with requirements of Owner and affected entities.

1. Owner will arrange to shut off indicated services/systems when requested.
2. Upon completion of work in affected areas, arrange to have utilities put back in service.

B. Maintain existing utility systems indicated to remain in service and protect them against damage. Post warning signs showing location and type of utility and type of hazard.

1. See Div. 01 Section "WORK RESTRICTIONS" for restrictions on utility interruptions.
2. When buildings or portions thereof will be occupied during demolition work, provide temporary services/systems that bypass areas of selective demolition and that maintain continuity of services/systems to occupied portions of building.

C. Locate and identify utility services and mechanical/electrical systems serving areas affected by demolition activities and ensure service has been shut off. Coordinate shutoff, capping, tapping, and extension of utilities.

1. Services to Remain: Temporarily disconnect power and cap services to remain to separate from portion to be demolished. Cap services immediately to prevent intrusion of contaminants and to allow systems to remain in operation to serve unaffected areas.
   a. Fire Protection, Plumbing, and Other Piping: Cap piping to remain with same or compatible piping material. Cap piping under floors, behind face of walls, above ceilings, or at mains.
   b. HVAC: Cut ductwork to remain neatly and cap and seal with same or compatible duct material.
   c. Electrical: Terminate conduit and wiring to remain in junction boxes with conductors properly isolated.
   d. If pipe, insulation, ductwork, conduit, wiring, or equipment to remain is damaged or unserviceable or, in areas to remain exposed to view in new construction, is damaged in appearance, remove damaged and unserviceable portions and replace with new products of comparable size and quality. Comply with Div. 01 Section "PRODUCT SELECTION OPTIONS."
   e. Existing Drains: Prior to the start of work in an area, test drainage system to ensure proper functioning. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until drainage systems function properly.

1) Prevent solids and pollutants from entering or blocking drainage systems. Use drain plugs specifically designed for this purpose. Solids include, but
are not limited to, adhesive or mortar residue, dirt, sand, sediments, or other debris. Pollutants include, but are not limited to, oil, grease, chemicals, non-water-soluble cleaning solutions, solvents, flammable liquids, or other liquids.

2) Clean out drains and drain lines that become sluggish or blocked by materials resulting from alteration work.

3) Remove drain plugs when no work is taking place or when no longer needed. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

2. Services to Be Removed: Remove portion of utility services indicated to be removed. Do not reuse removed materials, unless otherwise indicated.
   a. Fire Protection, Plumbing, and Other Piping: Remove unused piping, pumps, tanks, valves, fittings, fixtures, equipment, and appurtenances including hangers, supports, and fastening attachments.
   b. HVAC: Remove unused ductwork, VAV boxes, dampers, fans, pumps, equipment, air outlets and inlets, and appurtenances including hangers, supports, and fastening attachments. Remove refrigerant from mechanical equipment to be removed according to 40 CFR 82 and regulations of authorities having jurisdiction.
   c. Electrical, Communications, and Electronics: Remove switchgear, panelboards, fixtures, equipment, raceways, conduit, boxes, cable, wiring, racks, and appurtenances including hangers and supports back to point of origination or last active device to remain. Where entire electrical circuits are removed, turn circuit breakers off and mark as "SPARE."

3. Services to Be Abandoned: Abandon unused utility services and leave in place.
   a. Fire Protection, Plumbing, and Other Piping: Drain liquids from piping and cap or plug piping to be abandoned with same or compatible piping material.
   b. HVAC: Cap and seal open ends of ductwork to be abandoned with same or compatible duct material.
   c. Electrical: Terminate wiring to be abandoned in junction boxes with conductors properly isolated.

4. Services to Be Removed and Relocated: Remove items to be relocated as specified above in reverse order to original assembly or placement. Protect removed items until relocation is complete. Repair and restore relocated items to proper functional condition. Provide new fittings and appurtenances required to complete the relocations and to restore to good operating order. Clean surfaces indicated to be refinished to comply with requirements specifying finishes.
   a. Fire Protection, Plumbing, and Other Piping: Clean and flush piping, pumps, tanks, valves, fittings, fixtures, equipment, and appurtenances free of mud, debris, fluids, and other contaminants.
   b. HVAC: Clean interior and exterior of ductwork, VAV boxes, dampers, fans, pumps, equipment, air outlets and inlets, and appurtenances.
   c. Electrical: Clean interior and exterior of switchgear, panelboards, fixtures, equipment, and exposed appurtenances.
   d. New materials of similar design and quality may be substituted for materials and items indicated to be relocated with Architect's approval. Comply with Div. 01 Section "SUBSTITUTION PROCEDURES."

D. Prior to placing utilities back in service:
   1. Ensure work affecting utilities is complete.
   2. Comply with requirements in Facility Services Subgroup Sections (Divisions 20-29) for testing and inspection of completed systems.

3.06 SELECTIVE DEMOLITION, GENERAL

A. Conform to applicable codes for demolition work, safety of structure, and fire safety.
1. Minimize noise and spread of dirt and dust.

B. Conduct selective demolition and debris-removal operations to minimize interference with roads, streets, walkways, and adjacent occupied and used facilities.

C. Remove existing construction only to extent indicated and as required to join new work to existing. Do not remove more than is necessary to allow for new construction.
   1. Assign work to trades skilled in procedures involved.
   2. Locate demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   3. Do not allow unexpected or uncontrolled movement or collapse of construction being demolished.

D. Conduct selective demolition systematically, from higher to lower levels. Complete selective demolition operations above each floor or tier before disturbing supporting members on lower levels.
   1. Lower structural framing members and large sections of material to ground by derricks, platforms hoists, or other suitable methods to avoid free fall and to prevent ground impact or dust generation.
   2. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

E. Cut, move, or remove items as necessary for access to alterations and renovation work. Replace and restore upon completion.

F. Remove, cut, and patch work in manner to minimize damage and to provide means for restoring products and finishes to their original or specified new condition.

G. Remove unsuitable materials not marked for salvage.

H. Cutting, General: Cut construction to be demolished at junctures with construction to remain in small sections. See Div. 01 Section "CUTTING AND PATCHING" for requirements and limitations for cutting and patching construction to remain.
   1. Temporarily cover openings in floors, chutes, piping, ducts, conduit, and similar items to remain.

3.07 SELECTIVE DEMOLITION OF SITE ELEMENTS

A. Fencing: Completely remove indicated fencing, gates and other related items. Remove concrete foundations for posts.

B. Paving, Curbs, Gutters, Walks, and Slabs: Completely remove indicated pavement full depth including aggregate base courses.
   1. Unless existing, full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

C. Vegetation: Remove trees, shrubs, and other vegetation designated for removal per Div. 31 Section "SITE CLEARING."
D. Fill depressions caused by removal of site elements with satisfactory soil materials unless further excavation or earthwork is indicated; comply with Division 31 Section "Earth Moving."

3.08 PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: For slabs and flatwork, use walk-behind, power-driven saws. For tight spaces, vertical and overhead work, use hand-held, power-driven or hydraulic saws. Use diamond blades specifically design for concrete cutting.
   1. Slabs-on-Grade: Cut perimeter of area to be demolished to a depth of at least 3/4 inch, then break up and remove, cutting reinforcement when encountered.
   2. Elevated Slabs: Cut concrete to a depth of at least 3/4 inch. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete.
   3. Beams and Columns: Support members to prevent unexpected movement. Using power-driven saws, cut concrete in workable size sections to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at area being demolished, cut reinforcement, and then remove section of concrete and lower to ground as specified above. Align cuts on opposite faces where both faces are exposed. Neatly trim openings to dimensions indicated.
   4. Precast Members: Support members to prevent unexpected movement and cut loose from supports. Lift and lower to ground as specified above.

B. Masonry: Cut using power-driven saws, then remove masonry between saw cuts. Use diamond blades specifically design for masonry cutting. Where new masonry adjoins existing, tie-in new work by toothing new work into existing.

C. Steel: Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Where portions of structural members are designated to remain, cut portion to be removed using cutting torches, then remove steel between cuts. Cut gage-metals and thin pipe and tubing with power saws. Use blades specifically design for material being cut.

D. Finished Wood Panels: Cut using power-driven or hand saws, then remove material between cuts. Use sharp, carbide-tipped blades specifically design for finished use with material being cut.

E. Metal Panels and Siding: Cut using power-driven saws, remove fasteners securing panels to support framing, then remove panels between saw cuts. Use blades specifically design for metal cutting.

F. Roofing: See Div. 07 "ROOF REPAIRS." Remove no more existing roofing than can be covered in one day by new roofing. Ensure building interior remains watertight and weathertight.

G. Door Hardware: Remove and salvage for Owner's use.

H. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

I. Carpet: Remove in large pieces, roll tightly, and wrap and secure in neat rolls. Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI).

J. Mechanical and Electrical Services: Cut pipe or conduit using power-driven or hand saws. Thread ends of piping as required to receive threaded caps. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
3.09 DISPOSAL OF DEMOLISHED MATERIALS

A. Dispose of demolished items and materials promptly. Comply with requirements in Div. 01 Section "Construction Waste Management and Disposal."

3.10 CLEANING

A. Remove debris and abandoned items from areas of work and from concealed spaces.

B. 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.

3.11 SELECTIVE DEMOLITION SCHEDULE

A. Existing Items to Be Removed and Salvaged:
   1. Unbroken bricks. Clean for reuse and stack neatly on pallets.
   2. Other items indicated on Drawings.

B. Existing Items to Be Removed and Reinstalled:
   2. Fire extinguishers and cabinets.
   3. Other items indicated on Drawings.
SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
B. Cast in place concrete includes the following:
   1. Foundations and footings.
   2. Slabs on grade.
   3. Foundation walls.
   4. Equipment pads and bases.
C. Related Requirements:
   1. Division 07 "Building Insulation" for underslab insulation.
   2. Division 09 for requirements relating to specified floor coverings, finishing, and curing of interior concrete floor slabs.
   3. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.3 DEFINITIONS
A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference prior to any work beginning by trade. Time, date and location as determined by a construction manager.
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete Subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections. In addition to Division 1 requirements, provide one half-size hard copy (paper) of any drawings submitted in the electronic files.

B. Product Data: For each type of product.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Designs shall be submitted a minimum of 48 hours prior to the placement of any concrete. Submit properties of mixtures for each class of concrete including:
   1. Mixture Identification by class
   2. Specified compressive strength, $f'_{c}$, that is applicable for the class
   3. Specified exposure class in Part 2, "PRODUCTS", Article “CONCRETE MIXTURES, GENERAL”
   4. Documentation of strength test records of similar class of concrete used to establish standard deviation in accordance with ACI 318, when test records exist
   5. Required average compressive strength, $f'_{cr}$, for each class of concrete
   6. Documentation of $f'_{cr}$ of proposed mixtures(s)
   7. Intended placement method
   8. Slump or slump flow
   9. Air content
   10. Density
   11. Water/cement ratio (w/cm), when specified
   12. Documentation supporting other specified requirements of concrete mixtures
   13. Nominal maximum aggregate size or Size number
   14. Type and information about the ingredient materials proposed for use including:
      a. Cementitious Materials
      b. Aggregates
      c. Admixtures
      d. Water
      e. Fibers, color pigments, and other additions
   15. Amounts of mixing water to be withheld for later addition at Project site.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Submit original shop drawings indicating the proposed construction joint locations to the Architect/Engineer at least 14 days prior to beginning formwork on the portion of the building in question.

1.6 INFORMATIONAL SUBMITTALS

A. Information submittals are mandatory submittals by the sub-contractor to the General Contractor, Construction Manager and Design Professional which are not returned but kept for the project record.

B. Material certificates in lieu of material laboratory test reports when permitted by Architect/Engineer. For each of the following, material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements.

   1. Cementitious materials.
   2. Admixtures. Provide certification that chloride content complies with specification requirements.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Waterstops.
   6. Curing compounds.
   7. Floor and slab treatments.
   10. Vapor retarders. Certificate shall include permeance ratings expressed in grains of water vapor per square foot per hour per inch of mercury.
   11. Semirigid joint filler.

C. Material Test Reports: For the following, from a qualified testing agency:

   1. Aggregates: Include sieve analysis, dry rodded unit weight of coarse aggregate, and the specific gravities of both fine and coarse aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

E. Field quality control reports: The independent testing laboratory shall submit laboratory test reports for concrete materials directly to the Architect/Engineer with copy to others in accordance with the provisions of section 014000 "Quality Requirements." State in each report whether or not the test specimens comply with the specified requirements, and indicate any deviations therefrom.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA’s “Certification of Ready Mixed Concrete Production Facilities.”

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

E. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures in accordance with the requirements of PART 2 PRODUCTS, article "CONCRETE MATERIALS".

1.9 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for more than one day in a row, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
4. Removal of formwork shall be delayed during cold weather to assure adequate structural strength, unless approved strength accelerating measures are taken.
5. Contractor shall provide to the Architect/Engineer a written description of procedures to be used for cold weather concreting in accordance with Part 1, “ACTION SUBMITTALS”. The details should include, but not be limited to, the following:
   a. Procedures for protecting the subgrade from frost and the accumulation of ice or snow on reinforcement or forms prior to placement.
b. Methods for temperature protection during placement.
c. Types of covering, insulation, housing, or heating to be provided.
d. Curing methods to be used during and following the protection period.
e. Use of strength accelerating admixtures.
f. Methods for verification of in-place strength.
g. Procedures for measuring and recording concrete temperatures.
h. Procedures for preventing drying during dry, windy conditions.

B. Hot-Weather Placement: Comply with ACI 301 and 305.1 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
3. Provide submittals required by ACI 305.1 in accordance with Part 1, "ACTION SUBMITTALS”.
4. Water Reducing and Retarding Compound: The manufacturer of the mixture shall submit in writing to the Architect/Engineer and the Contractor, special recommendations for quantities to be used under various temperature and job conditions to assure that the concrete can be maintained at a uniform consistency while in the mixer truck and sufficiently workable between lifts to prevent the occurrence of lift lines with the specified placement and consolidation techniques, and as approved by the Architect/Engineer. Assure that the proper admixture and dosage is used during hot weather (mix temperature over 90 deg F.) to prevent slump loss from plant to site.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Hole Forms: Plastic, removable, coiling forms for handrail and guardrail post supports.
   1. Basis-of-Design: Econ-O-Post Hole Form, Deslauriers, Inc. 800-743-4106
      www.deslinc.com
      a. For post up to 2-3/8 inch outside diameter: EPHF-3.
      b. For post greater than 2-3/8 inch outside diameter to 3-1/2 inch outside diameter: EPHF-4.
   2. Coordinate locations with post indicated on plans, shop drawings, setting drawings and with railing installers. Coordinate form sizes required with post sizes.

D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.


F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent with a maximum of 350 g/l volatile organic compounds (VOCs) that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

H. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that leave no corrodible metal closer than 1 1/2 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

I. Expanded polystyrene (EPS) and Extruded polystyrene (XPS) Forms: Complies with ASTM D6817 / D6817M, treated to resist insects and suitable for below grade applications; EPA registered treatment, meeting requirements of ICC ES AC239, and recognized in an ISS ES report.
   1. Products: Subject to compliance with requirements, product which may be incorporated in the Work include, but are not limited to, the following:
      a. Foam-Control EPS; 952-892-0809; www.geofoam.com
      b. InsulFoam GF; 403-248-6616; www.insulfoam.com
      c. Atlas EPS; 616-878-1568; www.atlaseps.com
      d. DOW Building Solutions; 800-583-2583; www.building.dow.com
      e. Owens Corning; 800-438-7465; commercial.owenscorning.com/products
      f. Kingspan; 800-241-4402; www.trustgreenguard.com/insulation-board
      g. Substitutions: Section 01 60 00-Product Requirements
   2. Minimum material requirements for EPS and XPS foams:
      a. Size: Largest practicable sizes.
      b. Thickness: As indicated.
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- Density: As indicated (1.15 lb/cu. ft, min.)
- Compressive Strength: As indicated (5.8 psi at 1% deformation, min.)
- Deformation: 1% maximum.

3. Connector Plates: Manufacturer’s galvanized or stainless steel plates with two-sided multi-barbed design, capable of piercing geofoam and resisting lateral movement between blocks during installation.

4. Lateral Holding Strength: 60 lbs.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars, including Deformed Bar Anchors: ASTM A 706/A 706M, deformed.

D. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615/A 615M, Grade 60 ASTM A 706, deformed bars, assembled with clips.

E. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.

F. Deformed-Steel Wire: ASTM A 1064/A 1064M.

G. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.


2.4 REINFORCEMENT ACCESSORIES

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

B. Zinc Repair Material: ASTM A 780/A 780M.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire or plastic according to CRSI’s “Manual of Standard Practice,” and as follows:
   1. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
   2. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2.5 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 100 miles of Project site from aggregates[ and cementitious materials] that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

B. 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.

C. Cementitious Materials:
   1. Portland Cement: ASTM C 150/C 150M, Type I, Type II, or Type I/II. Type III cement may be used in lieu of Type I at contractor's option, when acceptable to the Architect/Engineer.
   2. Fly Ash: ASTM C 618, Class F.
   3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

D. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source[ with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: As indicated in Section 2.13 "CONCRETE MIXTURES FOR BUILDING ELEMENTS".
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
   3. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling. Do not use aggregates containing soluble salts or other substrates such as iron sulfides, pyrite, marcasite or ocher which can cause stains on exposed concrete surfaces.
   4. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect/Engineer.
   5. Alkali Silica Reactivity: Aggregate shall be considered non-reactive with a documented satisfactory service record for a minimum ten year period used in concrete with similar cementitious material or with an alkali (Na₂O eq.) content in concrete equal or higher than that in the proposed mixture. In the absence of service record the aggregate shall be tested and will be considered non-reactive if it passes on of the following two requirements – ASTM C1260 14-day expansion less than or equal to 0.10% or ASTM C1293 1-year expansion less than or equal to 0.040%. For aggregate that do not meet these criteria, mitigation measures shall apply in accordance with Part 2, "PRODUCTS", Article "CONCRETE MIXTURES, GENERAL".

E. Air-Entraining Admixture: ASTM C 260/C 260M.
   1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
      a. MasterAir VR 10 or MasterAir AE 200; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.bASF.us
      b. Eucon Air Mix or Eucon Air series; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
      c. Darex AEA or Daravair series; W. R. Grace & Co.-Conn; 866-333-3726; www.graceconstruction.com
      d. Sika AEA series of Sika Air series; Sika Corporation, USA; 800-933-7452; www.sikaconstruction.com
CAST-IN-PLACE CONCRETE

F. 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.
   a. Products: Subject to compliance with requirements, product which may be incorporated in the Work include, but are not limited to, the following:
      1) MasterPozzolith or MasterPolyheed; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
      2) Eucon WR or Eucon MR; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
      3) WRDA series; W. R. Grace & Co.-Conn; 866-333-3726; www.graceconstruction.com
      4) Plastocrete 161; Sika Corporation, USA; 800-933-7452; www.sikaconstruction

2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   a. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
      1) MasterSet R 300; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
      2) Eucon Retarder 75; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
      3) Daratard 17; W. R. Grace & Co.-Conn; 866-333-3726; www.graceconstruction.com
      4) Plastiment; Sika Corporation, USA; 800-933-7452; www.sikaconstruction
      5) Metco WR; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com

3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F and/or High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   a. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
      1) Super P; Anti-Hydro International, Inc.; 800-777-1773; www.anti-hydro.com
      2) MasterRheobuild 1000; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
      3) Eucon 37; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
      4) Daracem series or ADVA series; W. R. Grace & Co.-Conn; 866-333-3726; www.graceconstruction.com
      5) Superslump ; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com
      6) Sikament series; Sika Corporation, USA; 800-933-7452; www.sikaconstruction.com

   a. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
      1) MasterSet FP 20; BASF Construction Chemicals – Building Systems; 722-8899; www.master-builders-solutions.basf.us
CAST-IN-PLACE CONCRETE

2.6 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,[ with factory-installed metal eyelets,] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:
   a. Williams Products, Inc.; 800-521-9594; www.williamsproducts.net
2. Profile: Flat dumbbell with center bulb at expansion joints and Flat dumbbell without center bulb at construction joints.

B. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

G. Permeability Reducing Admixtures: Concrete waterproofing and protection system shall be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure within the pores and capillary tracts of the concrete for all basement walls and floor slabs.
1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   a. WT-215 P Crystalline Permeability Reducing Admixture; Sika; 800-933-7452; www.sikaconstruction.com
   b. Admix C-500/C-500 NF; Xypex; 800-961-4477; www.xypex.com

H. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   a. MasterLife CI 30; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
   b. Eucon BCN or Eucon CIA; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
   c. DCI or DCI-S; W. R. Grace & Co.-Conn; 866-333-3726; www.graceconstruction.com
   d. Sika CNI; Sika Corporation, USA; 800-933-7452; www.sikaconstruction.com

I. Water: ASTM C 94/C 94M and potable. [Non-potable water sources, with documented conformance of ASTM C1602, may be submitted for approval by the Architect/Engineer prior to construction.]
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:
   a. Greenstreak; 800-325-9504; www.greenstreak.com
   b. Vinylex Corporation; 800-325-3602; www.vinylexwaterstop.com
1. Profile: Flat dumbbell with center bulb at expansion joints] and [Flat dumbbell without center bulb at construction joints.

C. Preformed Plastic Adhesive Waterstops: Federal Specification SS S 210A. It shall be supplied in extruded form of suitable cross section and of a size to seal the joint areas of concrete sections. The plastic waterstop shall be protected by a suitable removable two piece wrapper. The two piece wrapper shall be so designed that one half may be removed longitudinally without disturbing the other half, to facilitate application of the sealing compound.
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include; but are not limited to, the following:
   a. Waterstop-RX; CETCO; 800-527-9948; www.cetco.com
   b. Synko Flex, Henry Company 800-486-1278 www.henry.com

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   1. Provide manufacturer's recommended mastics and gusset tape at all joints, to create a continuous membrane.
   2. Products for Slab-on-Grade: Subject to compliance with requirements, products which may be incorporated in the Work include the following:
      a. VB-250 and VB-350; Inteplast Group; 877-535-0555; www.barrierbac.com
      b. VaporBlock Plus; Raven Industries Inc.; 605-335-0174; www.ravenefd.com
      c. 15 mils thick Stego Wrap; Stego Industries, LLC; 877-464-7834; www.stegoindustries.com
      d. 15 mils thick Perminator; W.R. Meadows, Inc.; 800-342-5976; www.wrmeadows.com
      e. Polyethylene sheet not less than 15 mils thick (must provide proof of compliance with ASTM E 1745).

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick. Must provide proof of compliance with ASTM E 1745.

C. Bituminous Vapor Retarder: 110-mil- thick, semiflexible, seven-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.
   1. Product: Subject to compliance with requirements, products which may be incorporated in the Work include the following:
      a. Premoulded Membrane Vapor Seal with Plasmatic Core; W.R. Meadows, Inc.; 800-342-5976; www.wrmeadows.com
   2. Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg; ASTM E 154.
3. Tensile Strength: 140 lbf/; ASTM E 154.

2.8 CHEMICAL HARDENERS

A. Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.
1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   a. MasterKure HD 300WB; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
   b. Surfhard; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
   c. Liqui-Hard; W.R. Meadows, Inc. 800-342-5976; www.wrmeadows.com
2. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components complying with ASTM C 309, Type I-D, Class A; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 mg per liter.
2. Do not use curing compound on recessed slab areas which receive paver tile, quarry tile, ceramic tile or terrazzo finish floor material. These areas shall be water cured only.
3. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   b. MasterKure CC series BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
   c. Cure and Seal series; Dayton Superior; 888-977-9600; www.daytonsuperior.com
   d. Eucocure VOX; Euclid Chemical Company ;800-321-7628; www.euclidchemical.com
   e. L&M Cure R; L&M Construction Chemicals, Inc.; 800-362-333; www.lmcc.com
   f. Seal N Kure; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com
   g. CS-309-25; W.R. Meadows, Inc.; 800-342-5976; www.wrmeadows.com
4. Products shall comply with the requirements of the California Department of Public Health’s “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.”

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   a. MasterKure ER 50; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
   b. Aquafilm series; Dayton Superior; 888-977-9600; www.daytonsuperior.com
   c. Eucobar; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
d. E Con; L&M Construction Chemicals, Inc.; 800-362-3331; www.lmcc.com

e. Waterhold; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com


B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:

   a. MasterKure CC Series; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us

   b. Cure and Seal series Dayton Superior 888-977-9600
   www.daytonsuperior.com

   c. Aqua- Cure VOX; Euclid Chemical Company; 800-321-7628; www.eucilichemical.com

   d. Dress & Seal WB; L&M Construction Chemicals, Inc.; 800-362-3331; www.lmcc.com

   e. Metcure; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com


2. Products shall comply with the requirements of the California Department of Public Health’s "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: [ASTM D 1751, asphalt-saturated cellulosic fiber].

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

1. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:

   a. Polyvinyl Acetate (Interior Only):

      1) PVA Bonding Agent J41; Dayton Superior; 888-977-9600; www.daytonsuperior.com

      2) Tammsweld; Euclid Chemical Company; 800-321-7628; www.eucilichemical.com

      3) Weld-Crete; Larsen Products Corp.; 800-633-6668; www.larsenproducts.com

      4) Herculox; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com

      5) Intralok; W.R. Meadows, Inc.; 800-342-5976; www.wrmeadows.com

   b. Acrylic or Styrene Butadiene:

      1) MasterEmaco A 660; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us

      2) Acrylic Bonding Agent J40; Dayton Superior; 888-977-9600; www.daytonsuperior.com

      3) SBR Latex; Euclid Chemical Company; 800-321-7628; www.eucilichemical.com
C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, at nonload bearing applications and Types IV and V, at load bearing applications, for bonding hardened or freshly mixed concrete to hardened concrete.
2. Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   a. MasterInject 1500; BASF Construction Chemicals – Building Systems; 800-722-8899; www.master-builders-solutions.basf.us
   b. Sure Bond J58; Dayton Superior; 888-977-9600; www.daytonsuperior.com
   c. Euco Epoxy System #452; Euclid Chemical Company; 800-321-7628; www.euclidchemical.com
   d. Epobond; L&M Construction Chemicals, Inc.; 800-362-3331; www.lmcc.com
   e. Metco Hi Mod Epoxy; Metalcrete Industries; 800-526-5602; www.metalcreteindustries.com
   f. Sikadur 32 Hi-Mod; Sika Corporation, USA; 800-933-7452; www.sikaconstruction.com
   g. Stonset Primer; Stonhard; 800-257-7953; www.stonhard.com
   h. Rezi-Weld 1000; W.R. Meadows, Inc.; 800-342-5976; www.wrmeadows.com

D. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than [5000 psi] at 28 days when tested according to ASTM C 109/C 109M.
B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than [5000 psi] at 28 days when tested according to ASTM C 109/C 109M.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

2. Design mixtures shall meet the specified strength and durability requirements listed below or as provided in the Contract Documents, whichever is more stringent. Exposure classes listed below are defined by ACI 318, and the design mixture shall comply with the durability requirements of each exposure class.

<table>
<thead>
<tr>
<th>Class</th>
<th>Location</th>
<th>Density</th>
<th>Nominal Max Aggregate Size</th>
<th>Exposure Classes</th>
<th>Min. f'c, psi</th>
<th>Requirements for Exposure Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Footings</td>
<td>Normal Weight Concrete</td>
<td>3/4 inch</td>
<td>F 0 S 0 P 0 C1</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Foundation Walls</td>
<td>Normal Weight Concrete</td>
<td>1 inch</td>
<td>F 1 S 0 P 0 C1</td>
<td>450</td>
<td>Max w/cm ratio of 0.45</td>
</tr>
<tr>
<td>C</td>
<td>Slabs-on-Grade (interior)</td>
<td>Normal Weight Concrete</td>
<td>1 inch</td>
<td>F 0 S 0 P 0 C0</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Slabs-on-Grade (exterior)</td>
<td>Normal Weight Concrete</td>
<td>1 inch</td>
<td>F 1 S 0 P 0 C1</td>
<td>450</td>
<td>Max w/cm ratio of 0.45</td>
</tr>
</tbody>
</table>

B. Cementitious Materials - Unless otherwise indicated in the Contract Documents, Section 2.13 for structural members, or as indicated below, concrete mixtures may use any cementitious materials listed in 2.5.

1. Cementitious materials other than Portland cement shall not exceed the ACI 318 limits for the designated exposure classifications of each mix class.

C. Limit water-soluble, chloride-ion content in hardened concrete to following limits depending on the exposure category assigned to the structural member identified in 2.12. The limits are stated in terms of chloride ions in percent by weight of cement.

1. Prestressed and post-tensioned concrete for all exposure categories – 0.06%
2. Reinforced in Exposure Category C0 – 1.00%
3. Reinforced in Exposure Category C1 – 0.30%
4. Reinforced in Exposure Category C2 – 0.15%

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Air Content: Provide total air content for each class of concrete based on the nominal maximum size of aggregate and the assigned exposure class for resistance to freezing and thawing indicated in 2.12. Concrete for members categories as Exposure Category F0 should be non-air entrained, unless noted otherwise on the Contract Documents.

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size, inch</th>
<th>Total Air Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposure Class F2 and F3</td>
</tr>
<tr>
<td>3/8</td>
<td>6.0 to 9.0%</td>
</tr>
<tr>
<td>1/2</td>
<td>5.5 to 8.5%</td>
</tr>
<tr>
<td>3/4</td>
<td>4.5 to 7.5%</td>
</tr>
<tr>
<td>1</td>
<td>4.5 to 7.5%</td>
</tr>
<tr>
<td>1-1/2</td>
<td>4.0 to 7.0%</td>
</tr>
<tr>
<td>2</td>
<td>3.5 to 6.5%</td>
</tr>
<tr>
<td>3</td>
<td>3.0 to 6.0%</td>
</tr>
</tbody>
</table>

F. Slump – Provide documentation in submittal prior to commencement of Work of target slump or slump flow value for each class of concrete. Consistency of concrete shall be established to facilitate placement with minimized potential for segregation.

G. Alkali silica reactivity – For structural concrete members that will be moist in service and when it is determined as per Section 2.2B that the aggregate source used needs to include mitigative measures, submit documentation demonstrating that the proposed cementitious materials used with the aggregates by ASTM C1567 tests with an expansion after 14 days of exposure less than or equal to 0.1%.

H. The installer and manufacturer shall coordinate to establish properties of fresh concrete to facilitate placement and finishing with reduced potential for segregation and bleeding. Factors shall include but are not limited to slump or slump flow, setting time, method of placement, rate of placement, hot and cold weather placement, curing, and concrete temperature. Selection of fresh concrete properties shall be notified to the Engineer of Record in the submittal.

I. Contractor shall indicate reportable changes in sources of materials and quantities when such changes are necessary to ensure constructability, performance of concrete and compliance with the specification requirements. The contractor is permitted to make minor adjustments less than the reportable deviations noted in the original submittal to concrete mixtures to ensure uniformity of concrete without a re-submittal for review or approval.
2.14 FABRICATING REINFORCEMENT

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

B. Identification: Deliver all reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

C. Rejected Materials: Reinforcing with any of the following defects will not be permitted in the work:
   1. Bar lengths, depths, and bends exceeding the specified fabrication tolerances. Bends or kinks not indicated on drawings or final shop drawings.
   2. Bars with reduced cross section due to excessive rusting or other cause.

2.15 CONCRETE MIXING

A. General: Concrete may be mixed at batch plants or it may be transit mixed as specified herein. Batch plants must comply with the requirements of ACI 304, with sufficient capacity to produce concrete of the quality specified, in quantities required to meet the construction schedule. All plant facilities are subject to the acceptance of the Architect/Engineer. Plant facilities shall be calibrated by testing agencies specifically qualified for this as frequently as necessary to insure accuracy to plus or minus 0.4% of the total capacity of the components of the plant, but at a frequency not to exceed 6 months.

B. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, furnish batch ticket information, and as specified, provided the quantity and rate of delivery will permit unrestricted progress of the work in accordance with the placement schedule. Discharge of the concrete shall be completed within 11/2 hours after water is added to the mix or by the time the drum has revolved 300 times, whichever occurs first.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of the structure during construction.

B. Construction loads, including reshoring loads, on in place construction shall at no time exceed the live load for which the in place construction was designed. If the contractor is uncertain about the design live loads, it shall be his responsibility to obtain these from the Architect/Engineer.

C. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
CAST-IN-PLACE CONCRETE

D. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   2. Class C, 1/2 inch for rough-formed finished surfaces.

E. Construct forms tight enough to prevent loss of concrete mortar.

F. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. Forms for Exposed Concrete: Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.
   1. Do not use metal cover plates for patching holes or defects in forms.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

L. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

M. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

N. Coat contact surfaces of forms with an approved, nonresidual, low-VOC form-release agent, according to manufacturer's written instructions, before placing reinforcement.
   1. Do not allow excess form coating material to accumulate in forms or come into contact with in place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.
   2. Coat steel forms with a nonstaining, rust preventative material. Rust stained steel formwork is not acceptable.

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.
1. Anchor bolts shall be set with securely fastened templates, and the threaded area shall be protected from concrete laitance. Anchor bolts shall be accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
   a. Where conduit, pipe, or other items are to be embedded in concrete beams, slabs, or columns, they shall be placed not closer than the diameter of the largest of the adjacent items and with a net reduction in the concrete area (of a 12 inch wide strip in slabs) not in excess of 9% without prior approval of the Engineer. The location of such embedded items shall generally be at the middle or centroid of the member.

3. Install dovetail anchor slots in concrete structures as indicated.

4. Hole Forms for Slabs: Install "hole forms" in concrete structures where railing posts are indicated on drawings.

5. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike off templates or compacting type screeds.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place may not be removed in less than 14 days and until concrete has achieved at least 70 percent of its 28-day design compressive strength. Determine potential compressive strength of in place concrete by testing field cured specimens representative of concrete location or members.
   2. Form facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

D. Do not remove “hole forms”.

3.4 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.
3.5 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect/Engineer to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Provide sufficient numbers of supports and of strength to carry the reinforcement. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Locate construction joints, if required, but not shown so as to divide the slab into areas not in excess of 6000 sq. ft.(as close to square in configuration as possible), unless otherwise accepted by the Architect/Engineer. Con-form to slab placement, where shown. Before adjacent pour is made, the surface shall be roughened to an amplitude of a minimum of 1/4 inch except at exposed surfaces.

2. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete. Bulkheads designed and accepted for this purpose may be used for slabs. Keyways are to be horizontal or vertical as directed by the Architect/Engineer. Install preformed plastic adhesive waterstops in the keyway of all construction joints where vinyl, bulb type waterstops are not detailed.

4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated in the Construction Documents. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface, dislodge aggregates, and before concrete develops random contraction cracks, but not longer than 12 hours after slab finishing.

2. Formed Contraction Joints: Insert premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, at least 7 days remove inserts and clean groove of loose debris.

3. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishes as may be safely done without dislodging aggregate.

4. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 WATERSTOP INSTALLATION

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

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed. Notify other trades to permit installation of their work. Notify the Architect/Engineer and Testing Laboratory 24 hours before placing concrete.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Do not use concrete which becomes non plastic and unworkable, or does not meet the requirements quality control limits, or which has been contaminated by foreign materials. Do not use re-tempered concrete. Remove rejected concrete from the project site and dispose of in an acceptable location.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

E. Concrete Conveying: Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods which will prevent segregation and loss of concrete mix materials.

1. Provide mechanical equipment of such size and design for conveying concrete to insure a continuous flow of concrete at the delivery end. Provide run ways above top of finished slab in all places for wheeled concrete conveying equipment for the concrete delivery point to the locations of final deposit. Do not wheel concrete directly over steel reinforcement. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.

F. Pumping Concrete: The Contractor may at his option use pumping machines for placing the concrete subject to the following requirements:

1. If for pumping requirements the mix design is other than specified, the Contractor shall furnish to the Architect/Engineer a mix for approval not less than 15 days prior to the time required for its use. The laboratory will make and test this mix design. After the results of these tests are noted and approval is received, this mix can be used. Cost of this laboratory work shall be paid by the Contractor.

2. Whenever concrete is placed by pumping, it is recommended a second pump complete with sufficient pipes and hose for a complete and independent set up, or other placement equipment, be at the job prior to any placing of concrete. The Contractor shall be responsible for any corrective work which results from equipment breakdown.

G. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

H. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

I. Bonding: Roughen surfaces of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent. Clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and to not leave laitance, loose particles of aggregate, or damaged concrete at the surface.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

2. After placing slabs, finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

3. Slope surfaces uniformly to drains where required.

C. Float Finish: After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Uniformly slope surfaces to drains. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand bed terrazzo; and where indicated.

2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
   b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Chemical Hardener Finish: On concrete floors which remain exposed and as directed apply chemical hardener finish to interior concrete floors. Apply liquid chemical hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat, 1/3 strength; second coat, 1/2 strength; third coat, 2/3 strength. Evenly apply each coat, and allow 24 hours for drying between coats.

   1. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.

   2. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

   1. Coordinate sizes and locations of concrete bases with actual equipment provided.

   2. Construct concrete bases as indicated on the Contract Documents.

   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.

   4. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

   5. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.12 CONCRETE PROTECTING AND CURING

A. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than three 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 4-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 3 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions, followed by shading or moist curing adequate to keep temperature of the concrete at 80 degrees F or below during the curing period. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

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.

5. Temperature of Concrete During Curing: When the atmospheric temperature is 85 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period.
Provide hot weather protection complying with the requirements of Part 1 "GENERAL", Article "FIELD CONDITIONS".

6. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations. Concrete trucks, cranes, or excessive concentrations of loads will not be permitted on any slab without prior written approval of the Architect/Engineer during the curing period or subsequent construction.

7. Sealer and Dustproofer: Apply a second coat of specified curing and sealing compound only to surfaces given a first coat.

3.13 LIQUID FLOOR TREATMENT APPLICATION

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than [seven] days’ old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.14 JOINT FILLING

A. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/4 inch in any dimension to solid concrete. Limit cut depth to 1 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area in inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval. Under no circumstances will "dusting" of wet concrete during finishing operations be allowed.

3.16 SOURCE QUALITY CONTROL

A. Concrete Batch Facility: The testing laboratory shall perform inspections of the concrete batching facility at intervals not to exceed one per 1,000 cubic yards of concrete placed or at least one each six months. The inspection shall include verification of the calibration of scales, aggregate analysis of the current stockpiles, verification of batching procedures, and compliance with the original mix design. First inspection shall take place before any concrete is placed. The cost of each inspection shall be paid by the testing allowance.

1. Test results will be reported in writing to Architect, Structural Engineer, ready mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7
day tests and 28 day tests. If any breaks are below specified or expected strengths, the Testing Laboratory shall report any visible anomalies.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

1. The testing laboratory shall monitor concrete properties at time of placement and report to the Contractor any deviation from the project specifications. It shall be the responsibility of the Contractor to control the concrete and comply with the project specifications. If the Contractor cannot adequately control the quality of the concrete, then the Architect/Engineer shall direct the testing laboratory to control the concrete. The cost of this service shall be paid for by the Contractor.

B. Perform testing and inspections as indicated on the Contract Documents.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof. One specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

5. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6. Compression Test Specimens: ASTM C 31/C 31M.

   a. Cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

7. Curing of Compression Test Specimens: After preparation of the test cylinders, to prevent evaporation of water from the unhardened concrete, cover the cylinders immediately after finishing with a non-reactive plate or impervious plastic sheeting. Protect the outside surface of cardboard molds from any source of water for the first 24 hours after casting. Field curing procedures for test cylinders for 28 day compressive strengths are not the same as those for determining strength for form removal time.

   a. For test cylinders for 28 days compressive strength determination, during the first 24 hours after molding, store all test cylinders under conditions that maintain the temperature immediately adjacent to the cylinders in the range of 60 to 80 degrees F. and prevent loss of moisture from the specimens. If the Architect/Engineer or testing laboratory have questions
concerning the storage temperature, they may require that the contractor provide a

temperature record of the cylinders by means of maximum minimum thermometers. At the
end of 20 hours plus or minus four hours, cylinders are to be transported to the laboratory;
removed from the molds, and placed in a moist condition at 73.4 plus or minus 3 degrees F.
until the moment of testing.

b. Cure test cylinders to be used for determining strength for form removal time as
nearly as practical in the same manner as the concrete in the structure. Cylinders shall be
stored in or on the structure as near the point of use as possible, and as far as is practical,
with the same exposure to the elements. Remove test cylinders from field storage and store
in lime water at 73.4 plus or minus 3 degrees F. for 24 hours plus or minus 4 hours
immediately before testing.

c. Cylinders shipped from the field to the laboratory shall be packed in sturdy wood
boxes or other suitable containers surrounded by wet sawdust or other suitable packing
material and shall be protected from freezing during shipment.

7 days, two specimens at 28 days, and retain one specimen in reserve for later testing if
required.

a. Test one set of two field-cured specimens at 7 days and one set of two specimens at
28 days.

b. A compressive-strength test shall be the average compressive strength from a set of
two specimens obtained from same composite sample and tested at age indicated.

c. If the compressive strength tests fail to meet the minimum requirements specified,
the concrete represented by such tests will be considered deficient in strength and subject
to additional testing as herein specified.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-
cured cylinders, Contractor shall evaluate operations and provide corrective procedures
for protecting and curing in-place concrete.

10. Strength of each concrete mixture will be satisfactory if every average of any three
consecutive compressive-strength tests equals or exceeds specified compressive
strength and no compressive-strength test value falls below specified compressive
strength by more than 500 psi.

11. Test results shall be reported in writing to Architect, concrete manufacturer, and
Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain
Project identification name and number, date of concrete placement, name of concrete
testing and inspecting agency, location of concrete batch in Work, design compressive
strength at 28 days, concrete mixture proportions and materials, compressive breaking
strength, and type of break for both 7- and 28-day tests.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may
be permitted by Architect but will not be used as sole basis for approval or rejection of
concrete.

13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete
when test results indicate that slump, air entrainment, compressive strengths, or other
requirements have not been met, as directed by Architect. Testing and inspecting agency
may conduct tests to determine adequacy of concrete by cored cylinders complying with
ASTM C 42/C 42M or by other methods as directed by Architect.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine
compliance of replaced or additional work with specified requirements.

15. Correct deficiencies in the Work that test reports and inspections indicate do not comply
with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of
finishing.
E. Formed Concrete Dimensional Tolerances: Formed concrete having any dimension smaller than required, and outside the specified tolerance limits, will be considered deficient in strength and subject to additional testing as herein specified.

1. Formed concrete having any dimension greater than required will be rejected if the appearance or function of the structure is adversely affected, or if the larger dimensions interfere with other construction. Repair, or remove and replace rejected concrete as required to meet the construction conditions. When permitted, accomplish the removal of excessive material in a manner to maintain the strength of the section without affecting function and appearance.

F. Strength of Concrete Structures: The strength of the concrete structure in place will be considered potentially deficient if it fails to comply with any of the requirements which control the strength of structure, including the following conditions:

1. Failure to meet compressive strength test requirements.
2. Concrete which differs from the required dimensions or location in such a manner to reduce strength.
3. Concrete subjected to damaging mechanical disturbances; particularly load stresses, heavy shock, and excessive vibration.
4. Poor workmanship and quality control likely to result in deficient strength.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
SECTION 04 01 20.53 - MASONRY CLEANING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Paint removal from existing exterior masonry.
   2. Cleaning of existing exterior clay and concrete unit masonry.

B. Related Sections:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 04 Section "MASONRY RESTORATION" for replacement of damaged and missing masonry, patching damaged masonry, and repointing mortar joints.
   4. Div. 04 Section "MASONRY RESTORATION MORTARING" for mortar materials and repointing mortar joints.

1.02 REFERENCES

A. Definitions:
   1. Garden Hose Spray: 40 to 60 psi; 7 to 10 gpm.
   2. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.

B. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. Brick Industry Association, The (BIA):
      a. Technical Note 20, August 2018 - Cleaning Brickwork.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Coordinate masonry cleaning with public circulation patterns at Project site. Some work is near public circulation patterns. Public circulation patterns cannot be closed off entirely, and in places can be only temporarily redirected around small areas of work. Plan and execute the Work accordingly.

B. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

C. Sequencing: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Inspect for open mortar joints and repair before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
   2. Clean masonry surfaces after removal of plant growth and paint, repairs, and repointing.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."
1.05 ACTION SUBMITTALS

A. Product Data: For each type of cleaning product. Include product description, recommendations for application procedures, precautions, and limitations. Include test data substantiating that products comply with requirements.

1.06 INFORMATIONAL SUBMITTALS

A. Test Reports:
5. Preconstruction test evaluation reports for cleaning procedures and products used with recommendations.
6. Product test reports for cleaning product.

C. Manufacturers’ instructions.

D. List of materials for use in cleaning mockups per Div. 01 Section "MOCKUPS."

E. Qualification Statements for cleaning specialist.

1. Include list of past Projects and contacts evidencing compliance with specified qualifications.

F. Special Procedure Submittals:

1. Cleaning Program: Written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used, protection of surrounding materials, and control of runoff during operations.
   a. If materials and methods other than those indicated are proposed for any phase of restoration work, add to the Cleaning Program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and worker's ability to use such materials and methods properly.

1.02 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:

1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
   a. Company: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-trained representatives who are available for consultation and Project-site inspection and assistance at no additional cost.

2. Cleaning Specialist Qualifications: Minimum 5 years experience under current organizational structure.
   a. Company: Company specializing in masonry cleaning using products as specified in this Section and whose work has a record of successful in-service performance with the following qualifications. Experience installing standard masonry is not sufficient experience for masonry cleaning work.
   b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
   c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress. Maintain sufficient experienced, trained staff to perform work according to specified requirements.

B. Mockups:

1. Intent: The intent of this Section is to clean masonry without damage. Test several cleaning methods on mockup areas. Perform tests on each type of masonry to be
cleaned. Test by simplest and least aggressive method first, followed by progressively more aggressive methods until acceptable results are achieved without damaging substrates. Utilize least aggressive method yielding satisfactory results for each type of stain or soil to be removed.

2. Field Mockups: Prepare mockups of cleaning process and procedures to demonstrate aesthetic effects and set quality standards for materials and execution.
   a. Location: As directed.
   b. Size: Approximately 100 sq ft for each type of substrate and surface condition.
   c. Test materials and methods on samples for possible adverse reactions. Do not use materials and methods known to have deleterious effect.
   d. Determine effectiveness of materials and methods.
   e. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
   f. Allow paint stripper to remain on surface for varying time periods in several locations to determine optimum time required.
   g. Perform multiple applications of varying concentrations of cleaning solution to determine optimum concentration.
   h. In general, use cold water and very-low to low pressure spray, unless otherwise indicated. Where more aggressive pressures and/or hot water are required test on mockup and obtain approval prior to use.
   i. Test adjacent non-masonry surfaces for detrimental reaction with paint stripper and cleaning solution.
   j. Ensure that materials and procedures will not discolor or damage existing surfaces.
   k. Appearance Standard: Cleaned and repaired surfaces shall have a uniform appearance as viewed from 20 foot distance by Architect. Perform additional paint and stain removal, general cleaning, and spot cleaning of small areas that are noticeably different, so that surface blends smoothly into surrounding areas.
   l. Perform operations in presence of Architect and manufacturer's representative.

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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.03 DELIVERY, STORAGE AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.04 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Comply with manufacturer's written requirements for maintenance of ambient temperatures, humidity, ventilation, and other conditions required to properly execute and protect the Work.
   2. Do not perform work when ambient or surface temperature is below 40 degrees F, during precipitation, or if these conditions are anticipated within 24 hours after completion of work.
   3. Do not perform work when wind could carry materials to adjacent or underlying materials, or to adjacent property.
   4. Proceed with installation only when existing and forecasted weather conditions permit work to be performed according to manufacturers' written instructions and warranty requirements.
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 EQUIPMENT

A. Spray Equipment: Capable of producing and maintaining required velocity and pressure at nozzle at consistent rates.

2.03 MATERIALS, GENERAL

A. Select materials and methods of use based on the following, subject to testing and approval on mockup:
   1. Previous effectiveness in performing the work involved.
   2. Little possibility of damaging exposed surfaces.
   3. Consistency of each application.
   4. Uniformity of the resulting overall appearance.
   5. Do not use products or tools that could do the following:
      a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
      b. Leave a residue on surfaces.

B. Source Limitations: Obtain each type of cleaning material from one source with resources to provide materials of consistent quality in physical properties.

C. Comparable products by manufacturers other than those listed herein will be considered.

2.04 PAINT REMOVERS

A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste formulation for removing paint coatings from masonry.
   1. Products:
      a. ABR Products, Inc.; 800 Brush Grade.
      d. Price Research, Ltd.; Price Heavy Duty Paint Stripper.
      e. PROSOCO; Enviro Klean Safety Peel 2, Sure Klean Heavy-Duty Paint Stripper, or Sure Klean Heavy-Duty Paint Stripper D.

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline formulation for removing paint coatings from masonry.
   1. Products:
      a. ABR Products, Inc.; Grip 'N Strip 800 Fast Acting.
      c. Dumond Chemicals, Inc.; Peel Away 1 System.
d. PROSOCO; Enviro Klean Safety Peel 1 or Enviro Klean Safety Peel 3 with Enviro Klean Overcoat.

C. Solvent-Type Paint Remover: Manufacturer's standard water-rinsable, solvent-type gel formulation for removing paint coatings from masonry.
   1. Products:
      a. ABR Products, Inc.; Super Bio Strip Gel.
      b. Diedrich Technologies Inc.; 505 Special Coatings Stripper.
      c. Dumond Chemicals, Inc.; Peel Away 2.
      e. Price Research, Ltd.; Price Strip-All.
      f. PROSOCO; Sure Klean Fast Acting Stripper.

D. Low-Odor, Solvent-Type Paint Remover: Manufacturer's standard low-odor, water-rinsable solvent-type gel formulation, containing no methanol or methylene chloride, for removing paint coatings from masonry.
   1. Products:
      a. ABR Products, Inc.; Super Bio Strip Gel.
      b. Cathedral Stone Products, Inc.; S-301, S-303, or S-305.
      c. Dumond Chemicals, Inc.; Peel Away 6, Peel Away 7, or Peel Away 21.
      d. PROSOCO; Enviro Klean Safety Peel 1 or Enviro Klean Safety Peel 3.

2.05 CLEANING MATERIALS

A. Water: Potable, clean, and free from acids, alkalies, and detrimental matter.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Non-Ionic Detergent: Synthetic organic compounds especially formulated to remove oily soil.
   1. Products:
      a. Igepal CA-630 by GAF.
      b. Tergitol 15-S-12 by Dow Chemical.
      c. Triton X-100 by Dow Chemical.

D. Job-Mixed Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium polyphosphate, 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

E. Job-Mixed Mold, Mildew, and Algae Remover: Solution prepared by mixing 2 cups of tetrasodium polyphosphate, 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.

2.06 ACCESSORY MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.
   1. Products:
      a. ABR Products, Inc.; Rubber Mask.
      b. Price Research, Ltd.; Price Mask.
      c. PROSOCO; Sure Klean Strippable Masking.

B. Miscellaneous Products: Select materials and methods of use based on the following, subject to approval of a mockup.
1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could do the following:
   a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
   b. Leave a residue on surfaces.

2.07 MIXES
   A. Mix materials in accordance with manufacturer's instructions to proportions determined by cleaning of mockup.

PART 3 - EXECUTION

3.01 PROTECTION
   A. Close off areas in which work is being performed to pedestrian and vehicular traffic.
   B. Protect persons, motor vehicles, surrounding surfaces of building being cleaned, building site, plants, and surrounding buildings from harm resulting from masonry cleaning work.
      1. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of cleaning work.
   C. Remove downspouts adjacent to masonry and store during masonry cleaning repairs. Reinstall when masonry cleaning and repair is complete.
      1. Provide temporary rain drainage during work to direct water away from building.

3.02 CLEANING MASONRY, GENERAL
   A. Follow procedures and precautions in BIA Tech Note 20.
   B. Proceed with cleaning in an orderly manner; work from bottom to top of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
   C. Use only those cleaning methods indicated for each masonry material and location.
      1. Sandblasting and other mechanical methods are prohibited.
      2. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
         a. Equip units with pressure gages.
      3. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
      4. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
   D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
   E. Water Application Methods:
1. **Water-Soak Application:** Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.

2. **Water-Spray Applications:** Unless otherwise indicated, hold spray nozzle at least 6 inches from surface of masonry and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.

F. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.03 **PRELIMINARY CLEANING**

A. **Removing Plant Growth:** Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal. Remove loose soil and debris from open masonry joints to whatever depth they occur.

B. **Preliminary Cleaning:** Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
   1. Carefully remove heavy accumulations of material from surface of masonry with a sharp chisel. Do not scratch or chip masonry surface.
   2. Remove paint and calking with alkaline paint remover.
      b. Repeat application up to two times if needed.
   3. Remove asphalt and tar with solvent-type paint remover.
      b. Apply paint remover only to asphalt and tar by brush without prewetting.
      c. Allow paint remover to remain on surface for 10 to 30 minutes.
      d. Repeat application if needed.

3.04 **PAINT REMOVAL**

A. **Paint Removal with Alkaline Paste Paint Remover:**
   1. Remove loose and peeling paint using low-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   2. Apply paint remover to dry, painted masonry with brushes.
   3. Allow paint remover to remain on surface for period recommended by manufacturer.
   4. Rinse with cold water applied by low-pressure spray to remove chemicals and paint residue.
   5. Repeat process if necessary to remove all paint.
   6. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended by chemical cleaner or afterwash manufacturer.
   7. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.

B. **Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:**
   1. Remove loose and peeling paint using low-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   2. Apply paint remover to dry, painted masonry with trowel, spatula, or as recommended by manufacturer.
   3. Apply cover, if required by manufacturer, per manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended by manufacturer or as determined in test panels.
5. Scrape off paint and remover and collect for disposal.
6. Rinse with cold water applied by low-pressure spray to remove chemicals and paint residue.
7. Use alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph, if necessary to remove remaining paint. 
8. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface for period recommended by chemical-cleaner or afterwash manufacturer.
9. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.

C. Paint Removal with Solvent-Type Paint Remover:
1. Remove loose and peeling paint using low-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted masonry with natural-fiber cleaning brush, deep-nap roller, or large paint brush.
3. Allow paint remover to remain on surface for period recommended by manufacturer. 
4. Agitate periodically with stiff-fiber brush. 
5. Rinse with cold water applied by low-pressure spray to remove chemicals and paint residue.

3.05 CLEANING BRICKWORK

A. Cold-Water Soak:
1. Apply cold water by intermittent spraying to keep surface moist.  
2. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned. 
3. Apply water in cycles with at least 30 minutes between cycles. 
4. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests. 
5. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by low-pressure spray.

C. Detergent Cleaning:
1. Wet masonry with cold water applied by low-pressure spray. 
2. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
3. Rinse with cold water applied by -pressure spray to remove detergent solution and soil. 
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

D. Mold, Mildew, and Algae Removal:
1. Wet masonry with cold water applied by low-pressure spray. 
2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
3. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.
4. Rinse with cold water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.06 CLEANING BROWNSTONE TERRA COTTA

A. Cold-Water Soak:
1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles with at least 30 minutes between cycles.
4. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
5. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by low-pressure spray.

C. Detergent Cleaning:
1. Wet masonry with cold water applied by low-pressure spray.
2. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
3. Rinse with cold water applied by low-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

D. Mold, Mildew, and Algae Removal:
1. Wet masonry with cold water applied by low-pressure spray.
2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
3. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.
4. Rinse with cold water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.07 CLEANING STONEWORK

A. Cold-Water Soak:
1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles with at least 30 minutes between cycles.
4. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
5. Remove soil and softened surface encrustation from stone with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by low-pressure spray.
C. Detergent Cleaning:
1. Wet stone with cold water applied by low-pressure spray.
2. Scrub stone with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that stone surface remains wet.
3. Rinse with cold water applied by low-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

D. Mold, Mildew, and Algae Removal:
1. Wet stone with cold water applied by low-pressure spray.
2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
3. Scrub stone with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that stone surface remains wet.
4. Rinse with cold water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

3.08 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, spray applied at low pressure.
1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash pavement surfaces to remove mortar, dust, dirt, and stains.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent inspecting agency to perform field inspections and to prepare reports. Allow inspectors, product manufacturers, and Architect's Project representatives use of lift devices and scaffolding, as needed, to perform inspections and observe progress and quality of Work.
1. Notify inspectors, product manufacturers, and Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated.
2. Do not relocate lift devices and scaffolding until inspectors, product manufacturers, and Architect's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

B. Manufacturer Services:
1. Require product manufacturers to provide periodic field surveillance of the handling, installation/application, protection and cleaning of their products.
2. Schedule periodic site visits to review work at the following times:
   a. After delivery and storage of products and after preparatory work on which work of this Section depends is complete, but before installation begins.
   b. Twice during progress of work at 25 and 60 percent complete.
   c. Upon completion of work, after cleaning is carried out.

3. Monitor and report installation procedures, weather and temperature conditions, and unacceptable conditions.

END OF SECTION 04 01 20.53
SECTION 04 01 20.91 - MASONRY RESTORATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Replacement of damaged and missing brick and stone.
2. Patching deteriorated and damaged stone.
3. Repointing mortar joints.
4. Removing abandoned anchors.
5. Painting steel uncovered during the work.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
3. Div. 04 Section "MASONRY RESTORATION MORTARING" for analysis of existing mortar, mortar materials, and mixes.

1.02 REFERENCES

A. Definitions:
1. Defective Mortar Joints: Joints in which mortar is missing, loose, spalled, eroded, powdered, broken, hollow, unsound, soft, or weathered more than 3/16 inch (5 mm) from original plane. Sound joints containing fine hairline cracks are excluded.
3. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

B. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.
1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
2. The Masonry Society (TMS):
3. U.S. Department of the Interior, National Park Service:

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Sequencing: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
1. Restore and clean masonry in following sequence:
   a. Replace damaged and missing masonry.
   b. Rout and repoint mortar joints.
   c. Clean restored masonry under provisions of Div. 04 Section "MASONRY CLEANING."

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2. Schedule the work to accomplish this requirement.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Samples: Brick and stone for replacement units in sufficient quantity to show full range of shape, color, texture, grain, veining, and finish to be expected.
   1. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
   2. For each stone type, provide sets of at least three 12-by-12-inch samples for each type, but no fewer than necessary to indicate full range and proportion of variations within range.
   3. Each type of patching compound in form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
   4. Each type of stone adhesive.
   5. Accessories: Each type of anchor, accessory, and miscellaneous support.

1.02 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For existing and replacement brick and stone.

B. Qualification Statements for restoration specialist, including field supervisors and workers, and Contractor's testing agency.
   1. Include list of past Projects and contacts evidencing compliance with specified qualifications.

C. Quality-control program.

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Restoration Specialist Qualifications: Company specializing in masonry restoration as specified in this Section and whose work has a record of successful in-service performance with the following qualifications. Experience installing standard masonry is not sufficient experience for masonry restoration work.
      a. Company Experience: Minimum five years under current organizational structure.
      b. Project Experience: Minimum five years experience on at least five projects of similar nature in past five years.
      c. Staff: Maintain sufficient experienced, trained staff to install Products according to specified requirements
   2. Contractor's Testing Agency Qualifications: Qualified according to ASTM E 699 and ASTM C 1093 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC Standard 17025.

B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.
C. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing as follows:
1. Select 4 samples from stockpiled material or from existing construction if no stockpile.
2. Test each type of existing brick and each proposed type of replacement brick per ASTM C 67 for the following:
   a. Compressive strength.
   b. 24-hour cold-water absorption.
   c. Five-hour boil absorption.
   d. Saturation coefficient.
   e. Initial rate of absorption (suction).
3. Test each type of existing stone as follows:
   a. Test per ASTM C 170 for compressive strength, wet and dry, perpendicular and parallel to rift.
   b. Test per ASTM C 99 for modulus of rupture, wet and dry, perpendicular and parallel to rift.
   c. Test per ASTM C 97 for absorption and bulk specific gravity.
4. Test each proposed type of replacement stone as follows:
   a. Test per ASTM C 170 for compressive strength.
   b. Test per ASTM C 99 for modulus of rupture.
   c. Test per ASTM C 97 for absorption and bulk specific gravity.

D. Mockups: Per Div. 01 Section "MOCKUPS" and as follows:
1. Field Mockup: Prepare mockups of each restoration process to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation
   a. Location: Architect will select areas to represent surfaces and conditions for cleaning.
   b. Size: Approximately 10 sq ft for each type of substrate and surface condition.
   c. Restore existing brick and stone in location approved by Architect.
   d. Show proposed:
      1) Brick replacement procedures.
      2) Stone patching techniques.
2. Masonry Repair: Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
   a. Replacement: Four brick units replaced.
   b. Patching: Three small holes at least 1 inch in diameter for each type of brick indicated to be patched.
3. Stone Repair: Prepare sample areas for each type of stone indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
   a. Replacement: Four stone units replaced.
   b. Partial Stone Replacement: Two partial stone replacements (dutchman repairs).
   c. Stone Plug Repair: Two stone plug repairs for each type of stone indicated to be plugged.
   d. Crack Injection: Apply crack injection in two separate areas, each approximately 36 inches long.
   e. Patching: Three small holes at least 1 inch in diameter
      1) Routing and repointing procedures.
2) Mortar color and texture.
3) Joint tooling sequence and profile.
4) Overall workmanship and procedures.

f. Appearance Standard: Cleaned and repaired surfaces shall have a uniform appearance as viewed from 20 foot distance by Architect.

4. Approved mockup may remain as part of the Work.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver brick and stone units to Project site strapped together in suitable packs or pallets or in heavy-duty crates and protected against impact and chipping.

B. Deliver each piece of stone with code mark or setting number on unexposed face, corresponding to Shop Drawings, using nonstaining paint.

C. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

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

E. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

F. Store sand where grading and other required characteristics can be maintained and contamination avoided.

G. Handle stone to prevent overstressing, chipping, defacement, and other damage.

1.05 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Minimum Conditions: According to referenced standards and product manufacturers' written instructions and specified requirements.

B. Protection of Work:
1. Cover open top and face of wall with strong waterproof membrane at end of each day or shutdown. Cover partially completed walls when work is not in progress.
2. Extend cover to prevent moisture from entering wall and secure in place by non-damaging methods.
3. Prevent staining and damage to exposed masonry.
4. Protect sills, ledges, and projections from mortar droppings; remove droppings immediately.

C. Cold-Weather Construction Requirements: Comply with TMS Spec.

D. Hot-Weather Construction Requirements: Comply with TMS Spec.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Project Source Limitations: Obtain each variety of brick and stone and type of repair material through one source from a single manufacturer.

2.02 BRICK MATERIALS

A. Brick: Reuse existing brick salvaged during demolition.
   1. If salvaged brick is of insufficient quantity or unsuitable for reuse, provide new brick or brick salvaged from an off-site source to match existing in compressive strength, absorption, initial rate of absorption, color, size, and surface texture.

2.03 STONE MATERIALS

A. Stone Matching Existing: Natural building stone of variety, color, texture, grain, veining, finish, size, and shape that match existing stone and with physical properties within 10 percent of those determined from preconstruction testing of selected existing stone.
   1. For existing stone that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.

   B. Cutting New Stone: Cut each new stone so that, when it is set in final position, the rift or natural bedding planes will match the rift orientation of existing stones.

2.04 MORTAR MATERIALS

A. Mortar: As specified in Div. 04 Section "MASONRY RESTORATION MORTARING."

2.05 ACCESSORIES

A. Setting Buttons and Shims: Resilient plastic, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units, less the required depth of pointing materials unless removed before pointing.

B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

C. Stone Repair Anchors and Pins: Mechanical fasteners and pins of Type 304 stainless steel; designed for stone stabilization and pinning stone pieces; matching shape and size of existing anchors unless otherwise indicated.

D. Patching Compound: Premixed cementitious mortar mix, color to match existing stone.

E. Epoxy: Multiple component, 100 percent solids, produced specifically for setting anchors in masonry.

F. Bonding Agent: Two component modified epoxy resin.
   1. Surface Preparation: Use coating requiring no better than SSPC-SP 3, "Power Tool Cleaning", surface preparation according to manufacturer's literature or certified statement.

H. Sealant: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

I. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
   1. Previous effectiveness in performing the work involved.
   2. Minimal possibility of damaging exposed surfaces.
   3. Consistency of each application.
   4. Uniformity of the resulting overall appearance.
   5. Do not use products or tools that could leave residue on surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Prior to beginning work examine existing mortar joints to determine procedures required to match new mortar to existing, including:
   1. Order in which horizontal and vertical joints were tooled.
   2. Style of tooling including depth and profile.

B. Protection of In-Place Conditions:
   1. Protect surrounding areas and surfaces from damage or disfiguration.
   2. Prevent mortar from staining face of surrounding masonry and other surfaces.
      a. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
      b. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
      c. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

3.02 ABANDONED ANCHOR REMOVAL

A. Remove abandoned anchors, brackets, and other extraneous items no longer in use unless indicated to remain.
   1. Remove items carefully to avoid spalling or cracking masonry.
   2. Notify Architect before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:
      a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
      b. Immediately paint exposed end of item with two coats of antitrust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
   3. Patch hole where each item was removed unless directed to remove and replace affected masonry unit.

3.03 REPLACEMENT OF DAMAGED AND MISSING MASONRY

A. Remove damaged and deteriorated masonry without damage to adjacent masonry.
B. Install new or salvaged masonry units where existing units are missing or were removed.

C. Establish lines, levels, and courses to match existing. Fit new masonry to bond and coursing of existing masonry.

D. Lay masonry plumb and true to line.

E. Do not shift masonry after mortar has achieved initial set. If adjustments must be made after initial set, remove mortar and replace with new.

F. Lay solid masonry units in full mortar bed, with full head joints.

G. Lay hollow masonry units with face shell bedding on head and bed joints.

H. Do not butter corners or excessively furrow joints.

I. Cut masonry with straight, true cuts and clean, unchipped edges. Prevent oversized or undersized joints. Discard damaged units.

J. Do not expose cut cells in finished work.

K. Where fresh masonry joins existing or partially set masonry, remove loose masonry and mortar; clean and lightly wet exposed surface of set masonry.

L. Do not permit mortar to accumulate in cavities.

M. Rake out joints to 1/2 inch depth.

3.04 STONE PATCHING

A. Small Spalled Areas, Minor Cracks and Holes, and Lightly Deteriorated Surfaces:
   1. Patch stone with patching compound to match existing.
   2. Remove deteriorated stone until sound material is reached.
   3. Score or groove contact surfaces of stone to form mechanical bond with patching compound.
   4. Lightly wet masonry. Apply chemical bonding agent in accordance with manufacturer’s instructions.
   5. Mix and apply patching compound in accordance with manufacturer’s instructions. Build up in maximum 1/2 inch thick layers.
   6. Allow each layer to cure minimum 12 hours before proceeding. Lightly wet set material and existing masonry before applying next layer.
   7. Finish patches to match color and texture of surrounding stone.
   8. Keep patches moist until fully cured.

B. Large Spalled Areas and Severely Deteriorated Surfaces:
   1. Resurface deteriorated stone with new stone to match existing.
   2. Remove deteriorated stone to point at which sound material is reached.
   3. Drill holes for dowels at interface of new and existing stone.
   4. Anchor new stone to existing with anchors set in epoxy.
   5. Finish new stone flush with existing.
3.05 PAINTING STEEL UNCOVERED DURING THE WORK

A. Notify Architect if steel is exposed during masonry removal. Where Architect determines that steel is non-structural remove and replace items with new steel as directed. Where Architect determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it in place as follows:
   1. Surface Preparation: Remove paint, rust, and other contaminants according to SSPC-SP 3, "Power Tool Cleaning" or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", as applicable to comply with paint manufacturer's recommended preparation.
   2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify Architect before proceeding.

3.06 REPOINTING MORTAR JOINTS

A. Rout out defective mortar joints.

B. Prepare dynamic (moving) joints and cracks to receive sealant as specified in Div. 07 Section "JOINT SEALANTS."

C. Repoint static (non-moving) joints with pointing mortar to match existing.

D. Remove existing mortar to depth equal to 2-1/2 times joint width, but not less than 1/2 inch or depth at which sound mortar is reached.

E. Power saws or grinders may be used as a preliminary step in removing horizontal joints only. Cut thin line down center of mortar joint; remove remaining mortar using hand tools. Use hand tools for vertical joints.

F. Remove mortar cleanly, without damaging masonry. Cut back of joints square.

G. Remove loose particles with compressed air or water.

H. Lightly wet masonry just prior to repointing.

I. Fill areas where mortar has been removed to greatest depth first.

J. Build up mortar in several 1/4 inch compacted layers until outer face of masonry is reached.

K. Allow each layer to reach thumbprint hardness prior to applying next layer.

L. If existing masonry has worn, rounded edges, recess mortar slightly from face of masonry.

M. When final mortar layer has reached thumbprint hardness, tool to match sequence and profile of existing. Avoid light streaks, hairline cracks, tool burning, open joints, and other defects caused by tooling when mortar is excessively wet or dry.

N. Remove excess mortar from edge of joint by brushing with stiff bristle brush; wire brushes not permitted.
O. If necessary to more closely match original mortar color and texture, artificially age mortar by one of the following methods:
   1. Lightly brush with stiff natural brush after tooling.
   2. Apply fine mortar spray with low pressure water after tooling.
   3. Staining is not permitted.

P. Rake out joints indicated for installation of sealant with square bottoms and clean sides before setting mortar has hardened.
   1. For movement joints, rake entire joint space free of mortar and other rigid materials for installation of sealant with backer rod.
   2. For non-moving joints, rake to uniform depth equal to joint width.

Q. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.07 JOINT-SEALANT INSTALLATION

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Div. 07 Section "JOINT SEALANTS." Remove excess sealant and smears as sealant is installed.

3.08 CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, spray applied at low pressure.
   1. Do not use metal scrapers or brushes.
   2. Do not use acidic or alkaline cleaners.

B. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash pavement surfaces to remove mortar, dust, dirt, and stains.

3.09 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry units are Owner's property.

B. Masonry Waste: Remove masonry waste and legally dispose of off Owner's property.
   1. Comply with Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT."

END OF SECTION 04 01 20.91
SECTION 04 05 13.91 - MASONRY RESTORATION MORTARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Analysis of existing mortar.
   3. Mortar mixes.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 04 Section "MASONRY CLEANING."
   4. Div. 04 Section "MASONRY RESTORATION."

1.02 REFERENCES

A. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. The Masonry Society (TMS):
   3. U.S. Department of the Interior, National Park Service:
      a. Preservation Brief No. 2 - Repointing Mortar Joints in Historic Brick Buildings.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Attendance Required: Architect, Owner, Contractor, manufacturer's representative, restoration specialist, and other parties directly affecting or affected by work of this Section.

B. Sequencing: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Restore and clean masonry in following sequence:
      a. Replace damaged and missing masonry.
      b. Rout and repoint mortar joints.
      c. Clean restored masonry under provisions of Div. 04 Section "MASONRY CLEANING."
   2. Schedule the work to accomplish this requirement.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."
1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Two cured mortar samples for each type and color, 6 inches long by 1/2 inch by 1/2 inch. Samples will be compared to existing unweathered sample to determine acceptability of match.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   2. Material certificates for cementitious materials. Include brand, type, and name of manufacturer.

B. Preconstruction Test Reports: Existing mortar analysis.

C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

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

E. Qualification Statements for Restoration Specialist and Contractor's testing agency.

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Contractor's Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS."

B. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing per Div. 01 Section "QUALITY REQUIREMENTS" on existing mortar as follows:
   1. Remove 4 unweathered samples of existing mortar from different locations.
   2. Retain one sample for later comparison.
   3. Break up samples individually with mallet until constituent parts remain. Examine under microscope to determine:
      a. Approximate proportions of aggregate, cement, and lime.
      b. Type, size, and color of aggregate.
      c. Presence of fillers and additives.
      OR
   4. Test mortar by petrographic examination and chemical analysis in accordance with ASTM C 1324; report the following:
      a. Volumetric proportions of aggregate, cement, lime, air, and other ingredients.
      b. Type, color, and gradation of aggregate.
      c. Presence of pigments or additives.

C. Mockups: Per Div. 01 Section "MOCKUPS" and Div. 04 Section "MASTONRY RESTORATION" and as follows:
   1. Prepare mockups of masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1.04 DELIVERY, STORAGE AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
FIELD CONDITIONS

A. 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.

B. Cold-Weather Construction Requirements: Comply with TMS Spec.

C. Hot-Weather Construction Requirements: Comply with TMS Spec.

PART 2 - PRODUCTS

COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

MORTAR MATERIALS

A. 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.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction, containing maximum 0.60 percent alkali (sodium oxide) and maximum 0.15 percent water soluble alkali by weight.
   1. Color: Use gray, nonstaining white, or combination thereof as required to match existing mortar.

C. Hydrated Lime: ASTM C 207, Type S.

D. Aggregate for Mortar: ASTM C 144; color, size, and type to match existing mortar.

E. Water: Potable, clean, and free from deleterious amounts of acids, alkalies, and organic matter.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products:
      a. Davis Colors; True Tone Mortar Colors.
      b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
      c. Solomon Colors, Inc.; SGS Mortar Colors.

G. Other Components: As determined by existing mortar analysis to produce visual and performance characteristics to match existing mortar.

H. Air Entraining, Antifreeze, Bonding, and Other Additives: Not permitted.

I. Premixed Colored Mortar: Not permitted.
2.03 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.

B. Proportions: As determined by existing mortar analysis.

C. Ultimate Compressive Strength: Not to exceed that of existing mortar or masonry.

PART 3 - EXECUTION

3.01 MIXING MORTAR

A. Thoroughly mix ingredients in quantities needed for immediate use.

B. Mix dry ingredients mechanically until uniformly distributed; add water to achieve workable consistency.

C. Discard lumpy, caked, frozen, and hardened mixes, and mixes not used within 2 hours after initial mixing.

D. Do not add antifreeze compounds to lower freezing temperature of mortar.

E. Provide consistent color for exposed mortar.

3.02 INSTALLATION

A. Install mortar under provisions of Div. 04 Section "MASONRY RESTORATION."

END OF SECTION 04 05 13.91
SECTION 04 20 00 - UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Clay face brick.

1.02 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of exposed masonry unit and colored mortar.

1.04 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product. For masonry units, include material test reports substantiating compliance with requirements.

B. 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.

1.05 QUALITY ASSURANCE

A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in DIV. 01 SECTION "QUALITY REQUIREMENTS" for mockups.
   1. Build sample panels for each type of exposed brick masonry construction in sizes approximately 48 inches long by 48 inches high.

1.06 FIELD CONDITIONS

A. 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 TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.01 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
   1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.02 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, jamb s, sashes, movement joints, headers, bonding, and other special conditions.

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.

2.03 CONCRETE 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.

2.04 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C 216 to match existing.

2.05 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, 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. Masonry Cement: Not allowed.
E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.

F. Colored Cement Products: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

G. Aggregate for Mortar: ASTM C 144.
   1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.


I. Water: Potable.

2.06 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

   2. Wire Size for Cross Rods: 0.187-inch diameter.
   3. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   4. Provide in lengths of not less than 10 feet.


D. Masonry-Joint Reinforcement for Multiwythe Masonry:
   1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.07 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.

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

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

D. Partition Top Anchors: One of the following:
1. 0.105-inch thick metal plate with a 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. 8 inch long by 0.108-inch thick metal plate with pre-drilled 7/16 inch attachment holes and with side edges bent down 2 inches to fit over top of CMU wall to restrain lateral movement.

E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.08 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Div. 07 Section "Flashing and Sheet Metal."

B. Solder for Sheet Metal Flashings: As specified in Div. 07 Section "Flashing and Sheet Metal."

2.09 MISCELLANEOUS MASONRY ACCESSORIES

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

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

2.10 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer’s standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.11 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.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended 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 masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type M.
3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Clay face brick.

E. 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 TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. 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.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.02 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.

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 head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

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

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

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

3.04 MORTAR BEDDING AND JOINTING

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

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
3.05 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. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

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

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

3.06 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with sealant.
   2. At multiwythe masonry walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
   3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

C. Install weep holes in exterior wythes in head joints of first course of masonry immediately above embedded flashing.
   1. Use open head joints to form weep holes.
   2. Space weep holes 24 inches o.c. unless otherwise indicated.

3.07 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 that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
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 TMS 602/ACI 530.1/ASCE 6 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.

3.08 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 comply with 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.  Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

F.  Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.09 REPAIRING, POINTING, AND CLEANING

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

B.  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 uncleaned for comparison purposes.
   3.  Protect adjacent surfaces from contact with cleaner.
   4.  Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5.  Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20 or with a proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 04 20 00
SECTION 05 05 13.21 - SHOP-APPLIED PAINT COATINGS FOR METAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes shop- or factory-applied thermosetting metal coatings as follows for metal materials specified in other Sections:

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 02 through 49 Sections specifying shop-applied paint coatings for metal by referencing this Section.

1.02 REFERENCES

A. Definitions:
   1. DFT: Dry film thickness.
   2. PVDF: Polyvinylidene fluoride.

B. Reference Standards: Perform coating Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. American Architectural Manufacturers Association (AAMA):
      a. AAMA 609/610, Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
      b. AAMA 621 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
      d. AAMA CW-10-97 - Care and Handling of Architectural Aluminum from Shop to Site.
   2. National Association of Architectural Metal Manufacturers (NAAMM) and the National Ornamental and Miscellaneous Metals Association (NOMMA):
      a. NAAMM/NOMMA AMP 500, Metal Finishes Manual for Architectural and Metal Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate submittal, selection, and coating procedures between the various Div. 02-49 Sections specifying shop-applied paint coating finishes to ensure acceptable matching of colors between the various items being coated. Where items are indicated to match coatings selected for other items, adjust formulations as required to achieve acceptable match.
   1. Color match between adjacent items will be deemed acceptable if Delta-E is 2 or less.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."
1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:
   1. Type of coating system (chemistry).
   3. AAMA compliance.
   4. DFT of each coat and total system DFT.

B. Color Samples: For each type, color, gloss, and texture of exposed products on specified substrate for verification from the applicator.
   1. Sample Size:
      a. 6 inches in length for linear materials.
      b. 4 inches square for sheet or plate materials.
   2. Include Delta E samples for adjacent colors from different applicators.

1.04 INFORMATION SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product and material manufacturers certifications that coating formulations being provided comply with specified AAMA standards and meet or exceed specified requirements of this Section.
   2. Applicator's certification that applied paint systems comply with specified AAMA standards.

B. Test and Evaluation Reports: As follows:
   1. Product test reports for each type of product to show compliance with referenced standards.

C. Sample warranties for finish.

D. Qualification Statements for applicator.
   1. Include coating manufacturer's licensee approval for applicator.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."
   1. Include a copy of AAMA 609/610.

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.06 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: Specializing in the manufacture of coatings specified in this Section that is a licensee of the resin manufacturer.
   2. Applicator Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A firm certified, approved, or otherwise qualified by coating manufacturer for application of coatings specified in this Section and who is approved by coating manufacturer to provide specified warranty.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Protect painted finishes on exposed metal surfaces from damage by applying a strippable, UV-resistant, temporary protective covering before shipping.

C. Furnish touch-up paint along with each material shipment.

1.08 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard warranty providing coverage against failures in materials or workmanship as follows:
   1. Failures include, but are not limited to, the following:
      a. Application defects including, but are not limited to, pinholes, deficient thickness, and improper surface preparation.
   2. AAMA 2005 Superior Performing Fluoropolymer Coatings: 20 year warranty providing coverage that coatings:
      a. Will not chip, crack or peel excluding minute fracturing which may occur in proper fabrication of building parts.
      b. Will not chalk in excess of ASTM D4214 Number 8 rating, per ASTM D4214.
      c. Will not change color more than five Delta-E Hunter units (square root of the sum of square Delta L, Delta a, and Delta b) per ASTM D2244, Method 6.3 when equally exposed to sun and elements.
      d. Furnish applicator's 10 year warranty providing coverage against failure of PVDF-based coating over improper pretreatment where coating was not applied per ASTM D1730, Type B, Method 5 or ASTM B449, Section 5.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 SHOP-APPLIED PAINT COATINGS, GENERAL

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Colors and Gloss: As selected from manufacturer's full range.

2.03 MANUFACTURERS

A. PVDF Resin Products:
   1. Kynar 500® FSF® by Arkema Inc.
   2. Hylar® 5000 by Solvay Specialty Polymers USA, LLC.
   3. Substitutions will not be considered.
B. AAMA 2605 Compliant PVDF Coating Products:
1. Trinar® Coil & Industrial Coatings by AKZO Nobel Coatings, Inc.
2. Duranar® Coatings by PPG Industries Inc.
3. Fluropon® Coatings by The Sherwin-Williams Company (formerly Valspar).
4. Sher-Nar® 5000 Coatings by The Sherwin-Williams Company.
5. Substitutions will not be considered.

2.04 APPLICATORS
A. Coating Applicators: Certified, licensed by AAMA and listed on AAMA Verified Components List, or otherwise approved by coating product manufacturer.

2.05 SUPERIOR PERFORMANCE ORGANIC EXTRUSION COATINGS
A. General: Provide products formulated without the use of LBC Red List chemicals.

B. Aluminum Extrusion Coatings:
1. AAMA 2605 liquid spray-applied coating formulated with minimum 70 percent PVDF fluoropolymer resin, by weight, in color coat.
2. AAMA 2605 powder coating formulated with minimum 70 percent PVDF fluoropolymer resin, by weight, in color coat.

2.06 SUPERIOR PERFORMANCE ORGANIC COIL COATINGS
A. Exposed Coil Coatings for Aluminum Sheet:
1. AAMA 2605 coil coating formulated with minimum 70 percent PVDF fluoropolymer resin, by weight, in color coat.

B. Exposed Coil Coatings for Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Sheet:
1. AAMA 621 coil coating formulated with minimum 70 percent PVDF fluoropolymer resin, by weight, in color coat.

C. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.07 ACCESSORIES
A. Touch-Up Paint: Liquid, brush-applied or air-drying spray finish in matching color.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION
A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

B. Verify accuracy of components, quantities, and sizes prior to application of finishes.

C. Prepare and pretreat metal surfaces to comply with referenced AAMA standards, coating and resin manufacturers' written instructions, and the following:
1. Prepare aluminum items for shop finishing per ASTM D1730.
2. Prepare galvanized iron and steel items for shop finishing per American Galvanizers Association "Guide to Preparing Hot-Dip Galvanized Steel for Paint."
3. Prepare non-galvanized iron and steel items for shop finishing as follows:
a. Clean surfaces to be finished. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

b. Exterior steel members: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

c. Interior steel members located in corrosive environments, high moisture environments, and equipment rooms: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

d. Where steel is to receive inorganic, zinc-rich, primer, prepare surfaces per SSPC-SP 10, "Near White Blast." Coordinate the required blast profile with the approved paint submittal prior to beginning surface preparation.

3.02 APPLICATION

A. After appropriate preparation and pretreatment, apply coating to exposed metal surfaces to comply with referenced AAMA standards and with coating and resin manufacturers’ written instructions.

B. Apply coatings either before or after forming and fabricating, as required by coating process and as required for maximum coating performance capability.

C. For components which are assembled or welded in factory, apply finish after fabrication is completed.

D. 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.

3.03 REPAIR

A. Repairing Damaged Finishes: Immediately after installation, clean abraded and other areas where coatings are damaged.
   1. Touch up minor scratches and abrasions in finishes in accordance with finish manufacturer’s instructions.
   2. Use same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   3. Apply with an artist brush or by spray to provide a minimum 2.0-mil dry film thickness.

3.04 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Protect coating either by application of strippable film or by other suitable material to protect the finish. Remove protective wrap from coated items at time of installation.

3.05 COLORS

A. Colors: Match colors indicated on Drawings.

END OF SECTION 05 05 13.21
SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Field-installed shear connectors.
3. Shop and Field Welding.
5. Prime Painting.

B. Related Requirements:

1. Section 036200 "Non-Shrink Grout" for structural steel bearing and base plate connections.
2. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.
2. Welded built-up members with plates thicker than 2 inches.
3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 COORDINATION

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

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

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference prior to any work beginning by trade. Time, date and location as determined by a construction manager.

1.6 ACTION SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections. In addition to Division 1 requirements, provide one half-size hard copy (paper) of any drawings submitted in the electronic files.

B. Product Data: For each type of product.

C. LEED Submittals:
   1. Product Data: For recycled content, indicating postconsumer recycled content and cost.
      a. Documentation for industry standard recycling rates are not compliant. Recycled content rates must be specific to that manufacturer and product type.
   2. Product Certificates: For materials manufacturer within 100 miles of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery of each raw material. Include distance to Project and cost for each raw material.
   3. Laboratory Test Reports for Credit IEQ 4.2: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Shop drawings prepared under supervision of a Registered Professional Structural Engineer licensed in the state of Michigan, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment Drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
   5. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other Sections.
6. Original contract documents shall not be reproduced for use as a portion of the Shop Drawings.
7. Identify members and connections of the Seismic-Load-Resisting System.
8. Indicate locations and dimensions of protected zones.
9. Identify demand critical welds.

E. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

F. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, shop-painting applicators, professional engineer, testing agency.

B. Welding certificates.

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

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

A. Source Limitations:
1. Steel shapes shall be domestically milled and manufactured. Foreign milled steel shall not be used.
2. To the greatest extent possible steel shapes shall be manufactured with recycled material and shall be manufactured locally.
B. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

C. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
   2. If recertification of welders is required, retesting will be Contractor's responsibility.
   3. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

F. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any non-compliance of original work and to show compliance of corrected work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast in place concrete or masonry, in ample time to not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

D. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360. Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.
      a. Promptly notify Architect/Engineer whenever design of members and connections for any portion of structure are not clearly indicated.

   2. Use Allowable Stress Design; data are given at service-load level.

B. Moment Connections: Type FR, fully restrained.

C. STRUCTURAL-STEEL MATERIALS

D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [50] percent.

E. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
   1. W-Shapes: 60 percent.
   2. Channels, Angles, M, S-Shapes: 60 percent.
   3. Plate and Bar: 25 percent.
   4. Cold-Formed Hollow Structural Sections: 25 percent.
   5. Steel Pipe: 25 percent.
   6. All Other Steel Materials: 25 percent.

F. W-Shapes: ASTM A 992/A 992M, Grade 50.

G. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M.

H. Plate and Bar: ASTM A 36/A 36M

I. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.

J. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
   1. Finish: Black except where indicated to be galvanized.

K. Welding Electrodes: Comply with AWS requirements.
2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Finish: Hot-dip or mechanically deposited zinc coating.
   2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Mechanically deposited zinc coating.

E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

F. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable ASTM F 1554, Grade 55
   1. Configuration: Straight, unless otherwise indicated.
   4. Washers: ASTM F 436, Type 1, hardened carbon steel.
   5. Finish: Plain, unless otherwise indicated on the Contract Documents.

G. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable ASTM F 1554, Grade 55, straight.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.
   4. Finish: Plain, unless otherwise indicated on the Contract Documents.

H. Threaded Rods: ASTM A 36/A 36M.
   3. Finish: Plain, unless otherwise indicated on the Contract Documents.

I. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
J. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.


L. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint, as specified in Division 5 section "Teflon Bearing Pads".

2.3 PRIMER

A. Primer: Exposed structural steel shall comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Galvanizing Repair Paint: ASTM A 780/A 780M.

2.4 GROUT

A. Grout for use under steel bearing or base plates shall be a high strength, non bleeding, non shrink grout of high durability, as specified in Division 3 section "Non-shrink Grout".

2.5 FABRICATION


1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" and SSPC-SP 2, "Hand Tool Cleaning."
F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened, unless otherwise indicated on the Contract Documents.
   2. All bolts shall have threads excluded from the shear plane.
   3. Torque wrenches shall be used to tighten high strength fasteners unless prior written approval has been obtained from the Architect/Engineer.
   4. If for any reason a high strength bolt has to be removed after being stressed to "Proof Load", it shall not be reused.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."
   3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 2
mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Structural steel delivered to the job site showing evidence of rust, mill scale, spatter, slag or flux deposits shall be either returned to the shop for proper cleaning and repriming, or sand blasted clean and reprimed at the job site.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

B. Minimize distortion and warpage of steel members being galvanized by following recommendations according to ASTM A 384/A 384 M.

1. Do not apply galvanizing using double-dip or progressive processes without Architect’s or Engineer’s written approval.
2. Galvanize lintels and exposed plates, angles, tubes, shelf angles and rolled shapes attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

A. General: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

1. Promptly remove and replace materials or fabricated components that do not comply.

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

1. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.

2. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

A. Bolted Connections: Inspect and test shop-bolted connections according to RCSC’s "Specification for Structural Joints Using High-Strength Bolts."

1. Verify that gaps of installed Direct Tension Indicators are less than gaps specified in ASTM F 959, Table 2.

B. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M. In addition to visual inspection, provide non-destructive testing as indicated by AISC 360 and
the contract documents, whichever is more stringent. Test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency’s option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
4. Radiographic Inspection: ASTM E 94.

C. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Shoring shall have the effect of being continuous down to foundation level unless written approval is obtained from Architect/Engineer to do otherwise. Point loads from shoring shall be distributed to main structural members as necessary to prevent localized overstressing of supporting members. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

B. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.
3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Cranes or other erection machinery shall not be permitted on the foundation slab. The construction shall be scheduled so the structural steel is not erected from the foundation slab.

E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

F. Splice members only where indicated. Splices will be permitted only with prior written approval of the Architect/Engineer.

G. Do not use thermal cutting during erection for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Architect/Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

J. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.
   1. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC’s "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, unless otherwise indicated on the Contact Documents.

B. Weld Connections: Comply with AWS D1.1/D1.1M[ and AWS D1.8/D1.8M] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
4. Where fillet welding of members thicker than one half inch is indicated on the drawings, preheating of members shall be accomplished as directed by the Testing Laboratory prior to welding.
5. Where one of the members is embedded in concrete, extreme care shall be taken not to overheat the concrete so as to cause cracking or spalling. Adequate time shall be allowed between multiple passes to allow cooling of the concrete adjacent to the welded members.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

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

C. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.

D. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using High-Strength Bolts."

1. Verify that gaps of installed Direct Tension Indicators are less than gaps specified in ASTM F 959, Table 2.

E. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, provide non-destructive testing as indicated by AISC 360 and the contract documents, whichever is more stringent. Test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

   a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

F. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Field Rusting: Special steps shall be taken after erection of steel members to prevent rusting. Any rust appearing on any structural member shall be removed by wire brushing, sand blasting, or other approved techniques. The area shall then be repainted per above. This process shall be continued until the steel member is enclosed in its final waterproof or architectural covering. The Contractor shall notify the Architect/Engineer so that all structural steel may be inspected not more than 36 hours prior to attachment of blocking, sheathing, and/or other covering materials.

END OF SECTION 05 1200
SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections. In addition to Division 1 requirements, provide one half-size hard copy (paper) of any drawings submitted in the electronic files.

B. Product Data: For each type of deck, accessory, and product indicated.

C. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
2. In addition to Division 1 requirements, provide one half-size hard copy (paper) of any drawings submitted in the electronic files.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Product Certificates: For each type of steel deck.

C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

D. Evaluation Reports: For steel deck, from ICC-ES.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.


1. Welded decking in place is subject to inspection and testing. Expense of removing and replacing portions of decking for testing purposes will be borne by Owner if welds are found to be satisfactory. Remove work found to be defective and replace with new acceptable work.


1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 DECKING MATERIALS

A. Source Limitations:

1. To the greatest extent possible steel shapes shall be manufactured with recycled material and shall be manufactured locally.

2.2 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half preconsumer recycled content not less than 25 percent.

2.3 ROOF DECK

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. Vulcraft Group, Division of Nucor Corporation; 936-687-4665; www.vulcraft.com
2. New Millennium Building Systems, LLC ; 870-722-4272; www.newmill.com
3. Epic Metals Corporation; 877-696-3742; www.epicmetals.com
4. Canam-buildings, a business unit of Canam Group; 866-466-8769; www.canam-construction.com

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade as Indicated on Contract Documents, G60 zinc coating.
2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade as Indicated on Contract Documents], G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
4. Profile Depth: As indicated on Contract Documents.
5. Design Uncoated-Steel Thickness: As indicated on Contract Documents.
6. Span Condition: Triple span or more.
7. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 ACCESSORIES

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

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Metal Cover Plates: Fabricate metal cover plates for end abutting floor deck units of not less than same thickness as decking. Form to match contour of deck units and approximately 6" wide.

H. Metal Closure Strips: Fabricate metal closure strips, for openings between decking and other construction, of not less than 0.045 inch min. (18 gage) sheet steel. Form to provide tight fitting closures at open ends of cells or flutes and sides of decking.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [16 gage] thickness, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and [level] [sloped] recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: ASTM A 780/A 780M.

M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions 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, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Maximum vertical dimension between deck units at a support shall be 1/16 inch.
2. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

D. Place deck panels flat and square, secured to adjacent framing with top flange having no warping in excess of 1/16 inch across any three adjacent flanges.

E. Do not place deck units on concrete supporting structure until concrete has cured and is dry.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work. Coordinate reinforcing requirements of openings in first paragraph below with applicable Sections. Reinforce openings as indicated on the contract documents, and not less than:
   1. Reinforce steel deck openings from 6 to 12 inches in size with 2x2x1/4 inch steel angles. Place angles perpendicular to flutes; extend a minimum of two flutes beyond each side of opening and fusion weld to deck at each flute.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Fastening Deck Units: The top flanges of the beams and the steel deck shall be free of paint, water, ice, oil, rust, or any other material which might interfere with the welding process.

J. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Install temporary shoring before placing deck panels if required to meet deflection limitations.

B. Uplift Loading: Install and anchor roof deck units to resist gross uplift loading as indicated on the Contract Documents.

C. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
   2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds As indicated on Contract Documents.
   3. Weld Washers: Install weld washers at each weld location where deck thickness is less than 0.028 inches.

D. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, length as required, carbon-steel screws.
   2. For decks with positive registering, interlocking male/female type side laps, join by button punching.
E. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

F. Masonry Bearing: Install deck over supporting masonry with a minimum bearing of 4 inches.

G. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.

H. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

I. Sound Absorption Batts: Install sound absorbing batts immediately prior to installation of roof insulation. Keep materials dry before, during, and after installation.

J. Provide minimum 1 inch thick soft composition rubber closures above walls and partitions contiguous to acoustical steel roof deck.

3.4 FIELD QUALITY CONTROL

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

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.5 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

END OF SECTION 05 3100
SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Exterior non-load-bearing wall framing.
   2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
   3. Ceiling joist framing.
   4. Soffit framing.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
   2. Section 061000 "Rough Carpentry" for subflooring, wall sheathing, or roof sheathing using wood-based structural-use panels, particleboard, fibrous-felted board, and foam-plastic sheathing.
   3. Section 074113 "Metal Roof Panels" for metal roof and soffit panels and accessories installed over cold-formed metal framing.
   4. Section 074213 "Metal Wall Panels" for metal wall and soffit panels and accessories installed over cold-formed metal framing.
   5. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
   6. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 DEFINITIONS

A. Uncoated Steel Design Thickness: Minimum uncoated thickness of cold-formed framing delivered to the Project site shall be not less than 95 percent of the indicated thickness used in the cold-formed framing design. Lesser thicknesses shall be permitted at bends due to cold forming. Where decimal thicknesses of framing are not indicated, the thicknesses in “gages” and “mils” shall be provided in conformance with the thicknesses indicated in the Steel Stud Manufacturers Association.

B. Producer: Entity that produces steel sheet coil fabricated into cold-formed members.

C. Engineer of Record: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing cold formed metal framing engineering services and is specifically hired to do so.
D. Engineering Services: Services performed by the Engineer of record for installations of cold-formed metal framing for this Project.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site prior to commencing the Work.
   1. Require attendance of parties directly affecting the Work of the section. The Engineer of Record shall be an attendee of the Preinstallation Conference. If the Engineer of Record is not able to attend the scheduled Preinstallation Conference, the conference shall be rescheduled as many times as necessary, until the Engineer of Record is able to attend the conference.
   2. Review conditions of installation, installation drawings, procedures and coordination with related work.
   3. Approved Cold-Formed Metal Framing shop drawings shall be reviewed at the Preinstallation Conference with the Engineer of Record present for the review.
   4. Review required inspecting, testing, and certifying procedures.
   5. The Owner’s Materials Testing Lab shall attend the Preinstallation Conference if the Owner has engaged the service of an independent lab for site inspections of CFMF.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

B. Shop Drawings:
   1. Provide shop/installation drawings prepared by cold-formed metal framing engineer.
   2. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   3. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel framing. For cold-formed metal framing, connection design including fasteners, clips, anchors and all other related aspects of the framing design: comply with all applicable model code required design loads. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Welding certificates.

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

D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
1. Steel sheet.
2. Expansion anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

F. Submittals required as part of component manufacturer’s and installer’s Quality Control Program(s) that include material control procedures, inspection procedures, and nonconformance procedures.

G. Component manufacturer’s and installer’s Quality Control Inspector qualifications.

H. Certificates of Compliance: Certificate from Professional Structural Engineer responsible for system design that system was designed in accordance with Contract Documents requirements, applicable Building Code, and generally accepted engineering practices.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Installer Qualifications: An experienced installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
   1. The installer shall establish and maintain quality control procedures and perform inspections to ensure that the work is in accordance with AISI referenced documents and Contract Documents.

C. Engineer of Record:
   1. Engage a qualified professional Engineer to prepare design calculations, Shop Drawings, and other structural data as required.
   2. The Engineer of Record shall perform two (2) site inspections during installation and one (1) site inspection at completion of cold-formed metal framing.
   3. The Engineer of Record shall provide reports, including any nonconformance, issued to the Construction Manager, Owner, and Architect/Engineer within 48 hours of inspection.

D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

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

F. AISI Specifications and Standards:
   1. Comply with AISI documents as referenced standards in the applicable version of the International Building Code for this project.
2. Comply with AISI S202-15 "Code of Standard Practice for Cold-formed Steel Structural Framing".
3. Comply with AISI S240-15 "North American Standard for Cold-Formed Steel Structural Framing", including Section D Quality Control and Quality Assurance.

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling in accordance with AISI's "Code of Standard Practice".

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation in accordance with AISI's "Code of Standard Practice".

C. The contractor shall verify that the framing materials delivered meet the requirements of the contract, construction documents, and submittals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated. The size of framing members indicated in the drawings, are minimum sizes – provide the indicated sizes, or larger sizes where structural engineering dictates larger sizes are required. Where larger sizes of studs, tighter spacing of studs or more studs are indicated by the Structural Engineer preparing the buildings framing design, provide these material increases to the job, at no additional cost of the Owner. In some instances, the stud sizes indicated may be larger than engineering analysis dictates are necessary - heavier indicated stud sizes may have been chosen, and subsequently indicated in order to support, or otherwise accommodate other building systems which require heavier stud gages than basic structural engineering (framing design to meet the Building Code) dictates – DO NOT DOWN-SIZE THE STUD SIZES INDICATED.

1. Design Loads: As indicated on Drawings
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Load-Bearing Wall Framing used behind masonry veneer: Horizontal deflection of 1/600 of the wall height.
   b. Exterior Load-Bearing Wall Framing used behind Limestone veneer: Horizontal deflection of 1/720 of the wall height.
   c. Exterior Load-Bearing Wall Framing not used behind masonry veneer: Horizontal deflection of 1/360 of the wall height.
   d. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft.
   e. Exterior Non-Load-Bearing Framing used behind masonry veneer: Horizontal deflection of 1/600 of the wall height.
   f. Exterior Non-Load-Bearing Framing not used behind masonry veneer: Horizontal deflection of 1/360 of the wall height.
g. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft.
h. Ceiling Joist Framing: Vertical deflection of 1/360 of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
   a. Upward and downward movement of 1 inch.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

   2. Wall Studs: AISI S211.
   3. Headers: AISI S212.
   5. Truss Design: AISI S214.

D. Design framing installed behind exterior ceramic tile walls to comply with ANSI A108.11-4.0-4.3 requirements for framing.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60 (Z180) unless otherwise indicated, G90 (Z275) at masonry curtain-wall framing.

C. Steel Sheet for Vertical Deflection Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60 (Z180) unless otherwise indicated, G90 (Z275) at masonry curtain-wall framing.
2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.

C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web to permit frictionless vertical movement, 68 mils (1.72 mm) minimum thickness, size as required by structural design calculations.

2. Manufacturers: Subject to compliance with requirements, provide the named product, or a comparable product by other manufacturer.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: As required to accommodate upward or downward deflection of primary structure.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: [0.0428 inch].
2. Flange Width: [1-5/8 inches].

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.

C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web to permit frictionless vertical movement, 68 mils (1.72 mm) minimum thickness, size as required by structural design calculations.
   www.steelnetwork.com
2. Manufacturers: Subject to compliance with requirements, provide the named product, or a comparable product by other manufacturer.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Flange Width: As required to accommodate upward or downward deflection of primary structure.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

   1. Minimum Base-Metal Thickness: 0.0428 inch.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members, with a minimum yield strength of 33,000 psi. Where any of the framing's minimum yield strength is greater than 33,000 psi, i.e. 50,000 psi, accessory minimum yield strength shall be match the framings minimum yield strength.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   9. Joist hangers and end closures.
2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC58 at masonry walls or ICC-ES AC308 at concrete walls as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
2. Type: Adhesive anchor.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780/A 780M, MIL-P-21035B, or SSPC-Paint 20.

B. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.

C. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.9 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI’s specifications and standards,
Engineer’s shop/installation drawings, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Grout bearing surfaces uniform and level to ensure full contact of bearing flanges or track webs on supporting concrete or masonry construction.
D. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

E. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, Engineer’s shop/installation drawings, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Provide supplementary framing, blocking, and bracing where metal framing systems are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, metal roof, wall, and soffit panels, and similar work requiring attachment. Where type of supplementary support is not otherwise indicated, comply with cold-formed metal framing manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported.

E. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

F. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

G. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

H. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
I. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

J. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Connect vertical deflection clips to bypassing studs and anchor to building structure.
3. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. At exterior walls where walls are adjacent to the primary building structure, connect vertical deflection clips with slip capability, to the studs and anchor the clips to the primary building structure. The connection at the stud is to allow vertical movement only, not horizontal movement. Tighten connection nuts for vertical movement only. Deflection clips shall have vertical slot connection holes for vertical movement. Locate the slots adjacent to the stud, not at the primary building structure. The slip fasteners at the studs shall allow vertical movement without the fastener being able to disconnect from and fall from the framing studs. Slip connection shall be with bolts, nuts and washers unless the framing manufacturer has other recommendations that are acceptable to the Architect – submit designs in shop drawings. If framing manufacturer does not have other permanent fastening options that are acceptable to the Architect, deform the bolt threads after the nuts are in place to create a permanent fastener installation.

F. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Subject to compliance with authorities having jurisdiction and other requirements, provide either bridging method indicated immediately above.
4. Where Portland Cement Plaster (PCP) is to be installed over walls, and the lath used in the PCP is welded wire lath, the wall bracing shall be provided in accordance with the International Building Code section 2308.9.3 or section 2308.12 regardless of type of studs used in the PCP wall.
G. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
   1. Install solid blocking at every other stud and at additional locations as indicated on shop drawings.

H. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:
   1. Stud Spacing: As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Install single deep-leg deflection tracks and anchor to building structure.
   2. Connect vertical deflection clips to studs and anchor to building structure.
   3. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
   1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
   2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
   3. Subject to compliance with authorities having jurisdiction and other requirements, provide either bridging method indicated immediately above.
   4. Where Portland Cement Plaster (PCP) is to be installed over walls, and the lath used in the PCP is welded wire lath, the wall bracing shall be provided in accordance with the International Building Code section 2308.9.3 or section 2308.12 regardless of type of studs used in the PCP wall.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within [12 inches] of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
   1. Install solid blocking at every other stud and at additional locations as indicated on shop drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.
3.6 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
   1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
   2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than 2 inches from abutting walls, and as follows:
   1. Joist Spacing: As indicated on Drawings.

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.
   1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to bottom flange of joists.
   2. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
   3. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
   4. Subject to compliance with authorities having jurisdiction and other requirements, provide any bridging method indicated above.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 ERECTION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
3.8 FIELD QUALITY CONTROL

A. Inspection: Component manufacturer and installer shall inspect the work as required by their Quality Control Program(s) per AISI S240-15.

B. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Field and shop welds will be subject to testing and inspecting.

D. Testing agency will report test results promptly and in writing to Contractor and Architect.

E. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 4000
SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Shelf angles.
   2. Metal ladders.
   3. Ladder safety cages.
   4. Structural-steel door frames.
   5. Metal bollards.
   6. Metal downspout boots.
   7. Loose steel lintels.

B. Products furnished, but not installed, under this Section include the following:
   1. Loose steel lintels.
   2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
   3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:
   1. Section 03 30 00 "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 04 20 00 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
   3. Section 05 12 00 "Structural Steel Framing."
   4. Division 5 Section "Metal Stairs" for metal-framed stairs with metal pan, metal plate, or grating treads.
   5. Division 5 Section "Gratings" for metal gratings.
   6. Division 5 Section "Pipe and Tube Railings" for metal pipe and tube handrails and railings.
   7. Division 5 Section "Decorative Metal" for decorative metal items fabricated from custom components.
   8. Division 5 Section "Decorative Metal Railings" for decorative metal handrails and railings fabricated from stock components.
   9. Division 6 Section "Rough Carpentry" for metal framing anchors and other rough hardware.
   10. Section 09 91 13 “Exterior Painting” for shop primers.
   11. Section 12 93 00 "Site Furnishings" for bicycle racks.
   12. Section 32 93 00 "Plants" for tree grates.
   13. Section 018113.14 “Sustainable Design Requirements – LEED v4 BD+C” for requirements relating to LEED compliance, and for reporting LEED data.
1.3 COORDINATION

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

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

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Grout.
   3. Paint products.

B. LEED Submittals:
   1. Product Data: For recycled content, indicating postconsumer recycled content and cost. 
      a. Documentation for industry standard recycling rates are not compliant. Recycled content rates must be specific to that manufacturer and product type.
   2. Product Certificates: For materials manufacturer within 100 miles of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery of each raw material. Include distance to Project and cost for each raw material.
   3. Laboratory Test Reports for Credit IEQ 4.2: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. 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. Including Steel clips or other shapes for supporting elevator rails or other elevator parts.
   3. Shelf angles.
   4. Metal ladders.
   5. Ladder safety cages.
   7. Metal bollards.
   8. Metal downspout boots.
   10. Bike racks.

D. Delegated-Design Submittal: For ladders including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

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

C. Welding certificates: Copies of certificates for welding procedures and personnel.

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

1.6 QUALITY ASSURANCE

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

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

C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. Galvanizing: Qualify procedures and personnel according to the following:
   1. ASTM A 123 “Specification for Zinc (Hot- Dip Galvanized) Coatings on Iron and Steel Products”.
   2. ASTM A 384 “Specification for Safeguarding Against Warpage and Distortion During Hot- Dip Galvanizing of Steel Assemblies”.
   3. CSA G 164 “Galvanizing of Irregularly Shaped Articles”.

1.7 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

1.8 FIELD CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements.
measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 “Quality Requirements,” to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Recycled Content of Steel Products: Combined postconsumer recycled content and preconsumer recycled content not less than 50 percent. 2012 IgCC

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

D. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

E. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

F. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

G. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
I. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) and as indicated.
   2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108-inch (2.8-mm) nominal thickness.
   3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230); 0.0966-inch (2.5-mm) minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel or hot-dip galvanized after fabrication.
J. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
N. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
O. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
P. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leadred red brass) or No. C84400 (leaded semired brass).

2.3 FASTENERS
A. General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening.
B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1) for Type 304 stainless steel and Group 2 (A4) for Type 316 stainless steel.
D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

F. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

G. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

H. Wood Screws: Flat head, carbon steel, ASME B18.6.1.


K. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329 and ASTM A153/A153M.

L. Post-Installed Anchors: chemical anchors.

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

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) for Type 304 stainless steel and Group 2 (A4) for Type 316 stainless steel for locations where stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M) are required.

M. Slotted-Channel Inserts (for guide rails at elevator shafts): Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting," Section 09 91 23 "Interior Painting" for items located inside the building envelope, and Section 09 96 00 "High-Performance Coatings." for items indicated to receive High-Performance Coatings.

B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

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

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
F. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

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

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

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

D. Form exposed work true to line and level 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. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

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

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

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

K. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Provide steel framing and supports indicated and as necessary to complete the Work. Includes clip or other supports for guide rails at elevators and any other supports needed at elevators to make their installation complete. Elevator requirements may vary from manufacturer to manufacturer. Coordinate with the elevator manufacturer for their guide rail clip requirements and other support requirements.

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. Cut, drill, and tap units to receive hardware, hangers, and similar items.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Galvanize miscellaneous framing and supports where installed at exterior locations and where indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
   1. Provide mitered and continuously welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:
   1. Comply with ANSI A14.3, unless otherwise indicated.
   2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:
   1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch (12.7-by-64-mm) steel flat bars, with eased edges.
3. Rungs: Tread Rung Design, inverted channel shape; 2-1/2 inch W by 1-1’8 inch D (64 mm W by 29 mm D), 14 gage steel or thicker, with serrated and punched top surface. steel bars.
4. Fit rungs in centerline of siderails; weld and grind smooth on inside rail faces.
5. Provide platforms as indicated, fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 3/4 inch (19 mm) in least dimension.
6. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
7. Galvanize and prime exterior ladders, including brackets.
8. Prime interior ladders, including brackets and fasteners, with appropriate primer for indicated type of finish coating.

C. Aluminum Ladders:
1. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:
   a. Alaco Ladder Company  888-0310-7040  www.alacoladder.com
2. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
4. Rungs: Round aluminum rungs, not less than 3/4 inch (19 mm) diameter and not less than 1/8 inch (3.2 mm) thick, with serrated surfaces. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or aluminum brackets and aluminum rivets.
5. Support each ladder at top and bottom with welded or bolted aluminum brackets.

2.9 LADDER SAFETY CAGES

A. General:
1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners, unless otherwise indicated.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:
1. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
4. Galvanize and prime exterior ladder safety cages, including brackets and fasteners.
5. Prime interior ladder safety cages, including brackets and fasteners, with appropriate primer for indicated type of finish coating.

C. Aluminum Ladder Safety Cages:
1. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
3. Vertical Bars: 1/4-by-2-inch (6.4-by-50-mm) flat bars secured to each hoop.

2.10 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Prime steel frames with appropriate primer for indicated type of finish coating.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with appropriate primer for indicated type of finish coating.

2.12 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe or 1/4-inch (6.4-mm) wall-thickness rectangular steel tubing.

B. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch (6.4-mm) wall-thickness steel tubing with an OD approximately 1/16 inch (1.5 mm) less than ID of bollards. Match drill sleeve and bollard for 3/4-inch (19-mm) steel machine bolt.

1. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate.

C. Prime bollards with appropriate primer for indicated type of finish coating.
2.13 METAL DOWNSPOUT BOOTS

A. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
   1. Outlet: As indicated

B. Prime cast-iron downspout boots with appropriate primer for indicated type of finish coating.

2.14 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. Galvanize plates.

C. Prime plates with appropriate primer for indicated type of finish coating.

2.15 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with appropriate primer for indicated type of finish coating.

2.16 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.17 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.

2.18 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2. Fill vent holes and grind smooth after galvanizing.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 09 91 13 "Exterior Painting" and primers specified in Section 09 91 23 "Interior Painting" unless zinc-rich primer is indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.19 ALUMINUM FINishes

A. As-Fabricated Finish: AA-M12.

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. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

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

B. Anchor supports for ceiling hung toilet partitions, operable partitions, overhead doors and overhead grilles securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
   1. Do not fill removable bollards with concrete.

B. Anchor bollards in concrete in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.

C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Fill bollards solidly with concrete, mounding top surface to shed water.
1. Do not fill removable bollards with concrete.

E. Anchor internal sleeves for removable bollards in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve. Fill annular space around internal sleeves solidly with nonshrink grout; mixed and placed to comply with grout manufacturer’s written instructions. Slope grout up approximately 1/8 inch (3 mm) toward internal sleeve.

F. Place removable bollards over internal sleeves and secure with 3/4-inch (19-mm) machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

3.4 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 nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 13 “Exterior Painting.”

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 5000
SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes miscellaneous lumber and plywood.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "WOOD TREATMENT."
   4. Div. 06 Section "SHEATHING."

1.02 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   3. NLGA: National Lumber Grades Authority.
   5. WCLIB: West Coast Lumber Inspection Bureau.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.04 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports: As follows:
   1. Evaluation Service Reports (ESR) from ICC-ES for the following:
      a. Power-driven fasteners.
      b. Powder-actuated fasteners.
      c. Expansion anchors.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent for 2-inch nominal thickness or less, no limit for more than 2-inch nominal thickness unless otherwise indicated.

2.02 TREATED WOOD PRODUCTS

A. Wood Treatment: Refer to Div. 06 Section "WOOD TREATMENT" for lumber and plywood required to be preservative-treated and fire-retardant-treated.

2.03 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction including, but not limited to, the following:
   1. Rooftop equipment bases and support curbs.
   2. Wood blocking and nailers.

B. Species: Any species graded by any grading agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

C. For items of dimension lumber size, provide Construction or No. 2 grade lumber.

D. For concealed boards, provide No. 2, Construction or No. 2 Common grade lumber.

E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
2.04 PLYWOOD EQUIPMENT BACKING PANELS
   A. Equipment Backing Panels: DOC PS 1, Performance Category 3/4, APA B-D, Group 1 or 2, Exposure 1, fire-retardant treated.

2.05 FASTENERS
   A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
      1. Where untreated wood is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or of Type 304 stainless steel.
      2. For preservative- and fire-retardant-treated wood, provide fasteners per Div. 06 Section "WOOD TREATMENT."

   B. Nails, Brads, and Staples: ASTM F 1667.


   D. Wood Screws: ASME B18.6.1.

   E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.

   F. Screws for Fastening to Non-Load-Bearing Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

   G. Lag Bolts: ASME B18.2.1.

   H. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

   I. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
      1. Material for Exterior Applications: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.06 MISCELLANEOUS MATERIALS
   A. Adhesives for Gluing Lumber to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION
   A. Per Div. 01 Section "EXAMINATION AND PREPARATION."
3.02 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Where wood-preservative-treated wood will contact galvanized metal decking and galvanized metal framing, provide continuous protection against contact and corrosion by one of the methods specified in Div. 06 Section "WOOD TREATMENT."

C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

D. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.

E. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.03 ROOFTOP EQUIPMENT BASE AND SUPPORT CURB INSTALLATION

A. Install solid wood blocking on roof decks to support equipment and curbs where such equipment and curbs do not have flanges intended for attachment directly to roof deck. Install in thicknesses to match insulation thickness.

3.04 WOOD BLOCKING AND NAILER INSTALLATION

A. Provide miscellaneous lumber as indicated and as required for roof edge and nailers and blocking, bracing, and support of gravity and pullout loads of heavy trim, counters, shelving, cabinets, fixtures, handrails, wall-mounted door stops, grab bars, toilet accessories, equipment, services, furnishings, and similar items that cannot be supported directly by wall assembly framing.

B. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

C. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

D. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

3.05 EQUIPMENT BACKING PANEL INSTALLATION

A. Install plywood backing panels for electrical, communications room, and other wall mounted equipment by fastening to studs with edges over firm bearing; coordinate locations and panel
sizes with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

B. Space fasteners at maximum 24 inches o.c. on vertical edges and into studs at horizontal edges and in field of board.

END OF SECTION 06 10 53
SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes sheathing for floor and wall surfaces.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "WOOD TREATMENT" for plywood required to be preservative-treated and fire-retardant-treated.
   4. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for plywood equipment backing panels.

1.02 REFERENCES

A. Definitions:
   1. OSB: Oriented Strand Board.
   2. Performance Category: As defined in DOC PS 1 and PS 2; used as the "nominal panel thickness" herein.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.05 INFORMATIONAL SUBMITTALS

1.06 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Stack panels flat with spacers beneath and between each bundle to provide air circulation.
   Protect sheathing from weather by covering with waterproof sheeting, securely anchored.
   Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 PERFORMANCE CRITERIA

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.

2.03 PLYWOOD WALL SHEATHING

A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2; APA Rated Sheathing; Exposure 1.
   1. Performance Category: As needed to comply with requirements specified, but not less than nominal thickness indicated.
   2. Span Rating: To suit framing spacing.
   3. Factory mark plywood panels to indicate compliance with applicable standard.

2.02 GYPSUM PANEL WALL SHEATHING

A. Glass-Mat-Faced Gypsum Sheathing: ASTM C 1177/1177M.
   1. Products:
      a. GlasRoc by CertainTeed Gypsum, Inc.
      b. Dens-Glass Gold by Georgia-Pacific Gypsum LLC.
      c. Gold Bond eXP by National Gypsum Company.
      d. Securock by United States Gypsum Company.
      e. Comparable products by other manufacturers will be considered.
   2. Type and Thickness: Type X, 5/8 inch thick.

B. Gypsum Panel Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 FASTENERS

A. Screws for Fastening Sheathing to Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.
   1. At wood-based structural panels provide screws with wafer heads and reamer wings.
   2. For preservative- and fire-retardant-treated wood, provide fasteners per Div. 06 Section "WOOD TREATMENT."
   3. At other sheathing types provide fasteners of stainless steel or with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

2.04 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 or ASTM D 3498 for plywood and ASTM C 557 for gypsum panel products that is approved for application indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."
3.02 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. NESP 272 for power-driven fasteners.

D. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

E. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections.

F. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

G. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

H. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to environment beyond time allowed by sheathing manufacturer.

3.03 WOOD STRUCTURAL PANEL INSTALLATION

   1. Space panels 1/8 inch apart at edges and ends.

B. Fasten panels as follows:
   1. Cold-Formed Metal Framing: Screw sheathing to framing.

3.04 GYPSUM SHEATHING INSTALLATION

A. Comply with ASTM C1280, GA-253, and with manufacturer's written instructions.
   1. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
   2. Install boards with a 1/4-inch gap where sheathing abuts masonry or similar materials that might retain moisture, to prevent wicking.

B. Fasten panels as follows. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
   1. Cold-Formed Metal Framing: Screw sheathing to framing.
   2. Wood Framing: Screw sheathing to framing.

C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

END OF SECTION 06 16 00
SECTION 06 20 00 - FINISH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes interior finish carpentry items as described in Part 2 Article "Description."

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "WOOD TREATMENT" for wood-preservative and fire-retardant treatment.
   4. Division 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for furring, blocking, and other carpentry work not exposed to view.
   5. Division 09 Section "PAINTING" for priming and backpriming of finish carpentry.

1.02 REFERENCES

A. Definitions:
   1. MDF: Medium-density fiberboard.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Shop Drawings: For carpentry items, indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.

B. Samples: For each species and cut and color of the following exposed products for verification.
   1. Sample Size:
      a. As wide as practical by 12 inches long for lumber and linear materials.
      b. 8 by 12 inches for panel materials.
      c. For items for field-applied transparent finish coordinate with Div. 09 Section "PAINTING" and apply each finish to one side and one edge.
   2. Each trim and molding profile.
   3. Lumber and panel products.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Stack wood materials flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
   2. Deliver wood materials only when environmental conditions meet requirements specified for installation areas. If materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.
B. Store interior panel products laid flat in the area in which they are to be installed for at least 48 hours prior to installation.

1.06 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Do not install materials that are wet, moisture damaged, or mold damaged.
      a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
      a. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
   2. Do not deliver or install materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 DESCRIPTION

A. Interior Woodwork Items:
   1. Standing and running trim.

2.03 WOOD TREATMENT

A. Wood Treatment: Refer to Div. 06 Section "WOOD TREATMENT" for lumber and plywood required to be and preservative-treated.

2.04 INTERIOR TRIM

A. Lumber Trim for Opaque Finish (Painted Finish):
   1. Species and Grade: Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; B Finish; NHLA.
   2. Maximum Hardwood Moisture Content: 13 percent.
   4. Face Surface: Surfaced (smooth).

2.05 MATERIALS, GENERAL

A. Lumber: DOC PS 20 and the following grading rules:
   2. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.

4. Provide dressed lumber, S4S, unless otherwise indicated.

2.06 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Interior Glues and Adhesives:
   1. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
   2. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

C. Sealant: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

D. Wood Filler: Solvent base or oil base, tinted to match surface finish color.

2.07 FABRICATION

A. Back out or kerf backs of the following members except those with ends exposed in finished work:
   1. Interior standing and running trim.

B. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

3.02 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

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

3.03 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.
C. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends. Comply with requirements in Div. 09 Section "PAINTING."

3.04 INSTALLATION, GENERAL

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.
   1. Do not use manufactured units with defective surfaces, sizes, or patterns.

B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   1. Scribe and cut finish carpentry to fit adjoining work.
   2. Before installing members, seal and refinish cut surfaces and ends of members.
   3. At interior woodwork, where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
   4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
   5. Coordinate finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate finish carpentry.

3.05 INTERIOR STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available to greatest extent possible. Do not use pieces less than 48 inches long except where shorter single-length pieces are necessary. Stagger joints in adjacent and related standing and running trim. Cope or miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
   1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
   2. Install trim after gypsum-board joint finishing operations are completed.
   3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.
   4. Fill gaps, if any, between top of base and wall with latex sealant.

3.06 PREPARATION FOR SITE FINISHING

A. Set exposed fasteners. Apply wood filler in exposed fastener indentations.

B. Sand work smooth.

C. Site Finishing: Per Div. 09 Section "PAINTING."

3.07 REPAIR

A. Replace finish carpentry that is damaged or does not comply with requirements. Finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.
B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
   1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.08 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean exposed and semi-exposed surfaces. Restore damaged or soiled areas.

3.09 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Protect installed products from damage from weather and other causes during construction.

END OF SECTION 06 20 00
SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes specially fabricated casework units as follows:
   1. HPDL-faced architectural casework.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood furring, blocking, shims, and hanging strips required for installing casework and concealed within other construction before casework installation.

1.02 REFERENCES

A. Abbreviations and Acronyms:
   1. HPDL: High-pressure decorative laminate.
   2. LPDL: Low-pressure decorative laminate (thermally fused melamine).
   3. MDF: Medium-density fiberboard.
   4. MDO: Medium-density overlay.

B. Definitions:
   1. Architectural casework includes wood furring, blocking, shims, and hanging strips for installing casework items unless concealed within other construction before woodwork installation.

C. Reference Standards: Perform Work according to standards specified for grades of architectural wood casework indicated for construction, finishes, installation, and other requirements and as specified herein, unless otherwise indicated.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. Architectural Woodwork Institute (AWI) / Architectural Woodwork Manufacturers Association of Canada (AWMAC) / Woodwork Institute (WI):
      a. AWI/AWMAC/WI - Architectural Woodwork Standards (AWS).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."
1.05 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products, HPDL, and adhesive for bonding decorative laminate.

B. Shop Drawings: Per AWMAC/WI (NAAWS) or AWI/AWMAC/WI (AWS) requirements.
   1. Show locations and sizes of cutouts and holes for countertop grommets, plumbing penetrations, electrical switches and outlets, and other items installed in architectural casework.

C. Samples for Initial Selection: For each type and color of the following:
   1. Sample Size: Manufacturer's standard.
   2. LPDL panels.
   3. Edgebanding material.

D. Samples for Verification: For each type, surface finish, and color of the following:
   1. Sample Size:
      a. As wide as practical by 12 inches long for lumber and linear materials.
      b. 8 by 12 inches for sheet and panel materials.
   2. HPDL laminates.
   3. LPDL panel with edge banding on one edge.
   4. Hardware samples per Div. 06 Section "CABINET AND DRAWER HARDWARE."

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Fabricator Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An employer of skilled workers trained to custom fabricate casework similar to those required for this Project and whose products have a record of successful in-service performance.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Do not deliver casework until plaster, painting and similar operations that could damage woodwork have been completed in installation areas.
   2. If casework must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.05 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Do not deliver or install casework until building is enclosed and weatherproof, wet work is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting products and procedures for offering comparable products.

2.02 PERFORMANCE CRITERIA

A. Quality Standard: Comply with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) standards in Grade or Grades specified.
1. The Contract Documents may contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.03 HPDL-FACED ARCHITECTURAL CASEWORK

A. Grade: Custom.

B. Construction Type: Frameless.

C. Cabinet Door and Drawer Front Interface Style: Flush overlay.

D. Facing for Exposed Exterior Surfaces: HPDL.
1. Edgebanding: Tape edge.

E. Facing for Exposed Interior Surfaces: HPDL.
1. Edgebanding: Tape edge.

F. Semiexposed Surfaces Except Drawer Bodies: LPDL.
1. Door and Drawer Edgebanding: Tape edge.
2. Other Edgebanding: Tape edge.

G. Dust Panels: 1/4-inch plywood or tempered hardboard above locking compartments and drawers if accessible from adjacent compartments, unless located directly under tops.

2.04 DRAWER BODIES

A. Drawer Bodies:
1. Drawer Subfronts, Backs, and Sides: Baltic birch plywood.
2. Drawer Bottoms: 1/4-inch hardwood plywood.

B. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
1. Join subfronts, backs, and sides with glued dovetail joints.
2. Finish drawer bodies with manufacturer's standard clear conversion varnish system (no stain).

2.05 COUNTERTOPS

A. Per Div. 12 Section "COUNTERTOPS."
2.06 MATERIALS

A. Materials, General: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

B. Wood Moisture Content: 5 to 10 percent.

C. Solid Wood: Hardwood and softwood lumber of species and characteristics indicated.

D. Composite Wood Products:
   2. Softwood Plywood: DOC PS 1
   3. Baltic Birch Plywood: Panels manufactured with one-piece faces and backs; multi-ply all-birch solid inner plies with all laminations of same species of wood as faces.
      a. Face Grades:
         1) Exposed Faces: B - Premium grade, patch free clear faces, uniform white in color.
         2) Semi-Exposed and Concealed Faces: BB - Sound grade, small, matching color oval patches in uniform white, one piece face veneer.
   4. MDF: ANSI A208.2, Grade 130.
   6. LPDL Panels: Particleboard or MDF finished with thermally fused, melamine- or polyester-resin impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

E. HPDL Facing: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
   2. NEMA LD 3 Grade:
      a. Flat Horizontal Surfaces: General Purpose Grade HGS or HGL.
      b. Flat Vertical Surfaces: Grade VGS or VGL.
      c. Semiexposed Backs of Panels with Exposed HPDL Faces: General Purpose Grade VGS.
      d. Concealed Backs of Panels with Exposed HPDL Faces: Backer Grade BKH, BKM, BKV, or BKL to match thickness of face.
   3. Colors, Patterns, and Finishes: As indicated by manufacturer's designations in the Finish Material Schedule.

F. Edgebanding: ABS, Polypropylene, Polyester, or PVC extrusions.
   1. Tape Edge: 0.5-mm thick.

2.07 CABINET HARDWARE AND ACCESSORIES

A. As specified in Div. 06 Section "CABINET HARDWARE AND ACCESSORIES."

2.08 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use
nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Decorative Laminate: Contact cement.

2.09 FABRICATION

A. Field Measurements: Where casework is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

B. Shop Fabrication: Fabricate casework to dimensions, profiles, and details indicated.

C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."
   1. Verify that field measurements are as indicated on shop drawings.
   2. Verify the adequacy and proper location of required backing and support framing.
   3. Verify that mechanical, electrical, plumbing, and other building components affecting work in this Section are in place and ready.

B. Before installing casework, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

C. Before installing casework, examine shop-fabricated work for completion and complete work as required.

3.02 INSTALLATION

A. Install casework to comply with specified standards and to comply with same grade as item to be installed.

B. Make cutouts for equipment where not done in shop.
3.03 REPAIR

A. Repair damaged and defective casework, where possible, to eliminate functional and visual defects; where not possible to repair, replace casework.

B. Replace panels that cannot be repaired to Architect's and Owner's satisfaction.

3.04 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Adjust doors and drawers for uniform vertical and horizontal alignment and proper operation.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean, lubricate, and adjust hardware.

C. Clean casework on exposed and semi-exposed surfaces.

END OF SECTION 06 41 00
SECTION 06 41 93 - CABINET AND DRAWER HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes cabinet and drawer hardware for architectural cabinets.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "ARCHITECTURAL WOOD CASEWORK" for cabinet construction and hardware installation.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Keying Conference: Conduct with Owner at Project site per Div.01 Section "PROJECT MEETINGS" prior to ordering locking hardware. Incorporate keying conference decisions into final keying schedule including, but not limited to, the following:
   1. Requirements for key control system.
   2. Address for delivery of keys.

B. Coordination: Coordinate requirements of this Section with Sections specifying casework in which hardware will be installed.
   1. Distribute copies of approved hardware submittals to fabricator of casework; coordinate Shop Drawings and fabrication with hardware requirements.
   2. Furnish templates and directions for installing hardware to fabricator of casework.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type and finish of exposed hardware and accessories for verification.
   1. Quantity: One unit for each type and finish.

C. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for door and drawer locks.

1.05 CLOSEOUT SUBMITTALS

A. Include final keying schedule.

1.06 QUALITY ASSURANCE

A. Mockups: Per Div. 01 Section "MOCKUPS" and as follows:
   1. Provide hardware required to build mockups required in casework Sections.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Deliver cabinet hardware to casework fabricator for installation in a timely manner.
   2. Deliver keys to Owner by registered mail or overnight package service.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

C. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

D. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

1.03 PERFORMANCE CRITERIA

A. Quality Standard: Comply with AWS and NAAWS standards.
   1. The Contract Documents may contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

1.04 HINGES

A. Concealed Hinges (European Style): 100 degrees of opening, self-closing.
   1. Frameless: ANSI/BHMA A156.9, B01602.

1.05 PULLS

A. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

1.06 SHELF RESTS

A. Bored Hole Shelf Rests for Cabinet Interior: Two peg, plastic clip system for 3/4 inch and one inch thick shelves with shelf hold-down clip.
   1. Basis-of-Design Product:
      a. No. 282-47-702 by Häfele.
      b. Comparable products by other manufacturers will be considered.
   2. Color: Provide white supports for cabinets with doors. Provide clear supports for open front cabinets.

1.07 DRAWER SLIDES

A. Drawer Slides: ANSI/BHMA A156.9 Grade 1; full-extension type; zinc-plated steel.
   1. Basis-of-Design Manufacturer:
      a. Accuride.
      b. Comparable products by other manufacturers will be considered.

1.08 LOCKS

A. Drawer and Door Locks: ANSI/BHMA A156.11, Grade 1; Interchangeable core insert, removable by use of a special key, and usable with other manufacturers' cylinders, master
Basis-of-Design Product:
1. 1E7E4 Slabbed Cabinet Mortise Cylinders by Best Access Systems.
2. Comparable products by other manufacturers will be considered.

B. Keying: Incorporate decisions made in keying conference.
1. Quantity: Two keys per lock and six master keys, unless otherwise required by Owner.

1.09 COUNTERTOP SUPPORT BRACKETS

A. Countertop Support Brackets: 'L' shaped brackets with predrilled mounting holes for wall mounting.
1. Products:
   a. A & M Hardware, Inc.; 18 by 24 inch Workstation Brackets.
   b. Lyman Associates; 18 by 24 inch Countertop Supports.
   c. Rakks/Rangine Corporation; EH-1824.
   d. Comparable products by other manufacturers will be considered.
2. Material: Formed steel or extruded aluminum.
3. Size: Form brackets to 18 by 24 inch size with minimum 1-1/2 inch attachment flanges.
4. Load Capacity: Capable of supporting not less than 450 pounds per bracket when properly installed.
5. Finish: As indicated or, if not indicated, as selected from manufacturer's full range.

1.10 GROMMETS

A. Grommets for Cable Passage through Countertops: Molded-plastic grommets and matching plastic caps with slot for wire passage.
1. Size: 3 inch cover, 2-1/2 inch bored hole, unless otherwise indicated.
2. Color: As selected from manufacturer's standards.
3. Basis-of-Design Product:
   a. Type EDP by Doug Mockett and Co., Inc.
   b. Comparable products by other manufacturers will be considered.

1.11 ACCESSORIES

A. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

1.12 FINISHES

A. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated.

B. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

PART 2 - EXECUTION

2.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

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CABINET AND DRAWER HARDWARE
2.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations.

B. Bored Hole Shelf Rests: Allow for vertical adjustment as follows:
   1. Base Cabinets: 6 inches up and down from center of cabinet.
   2. Wall and Tall Cabinets: Continuous from 4 inches below top to 4 inches above bottom of cabinet.

2.03 QUANTITY

A. Hinges: Per AWS and NAAWS standards.

B. Pulls: As follows, unless otherwise indicated:
   1. Cabinet Doors: One pull installed vertically.
   2. Drawers up to 24 Inches Wide: One pull installed horizontally.
   3. Drawers Over 24 Inches Wide: Two pulls installed horizontally.

C. Door Catches: One per cabinet door with non-self-closing hinges.

D. Locks: Provide locks where indicated.

E. Wire Access Grommets: Verify quantity and location with Architect and Owner. Install as directed wherever power, phone, cable, and data terminals occur below countertop surfaces.

2.04 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.

C. Lubricate hardware as required.

END OF SECTION 06 41 93
SECTION 07 01 50.19 - PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes partial roof tear off including removal of base flashings.
   1. Roof re-cover preparation.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Sections specifying new roof system, flashing, specialties and accessories.

1.02 REFERENCES

A. Definitions:
   1. Roof System: Includes roofing membranes, auxiliary roofing materials and accessories, substrate boards, vapor retarders, roof insulation, insulation accessories, cover board, walkway products, metal edging and flashing integral to the roof, metal copings protecting edges of roof, and other roofing components.
   2. Roofing Terminology: Definitions in the following apply to work of this Section:
      a. ASTM D 1079.
   3. Existing Roofing System: Includes roofing membranes, auxiliary roofing materials and accessories, substrate boards, vapor retarders, roof insulation, insulation accessories, cover board, ballast, walkway products, metal edging and flashing integral to the roof, metal copings protecting edges of roof, and other roofing components.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct meetings at Project site per Div. 01 Section "PROJECT MEETINGS."
   1. Attendees: Per Div. 01 Section "PROJECT MEETINGS." Include Owner's insurer if applicable, testing and inspecting agency representative; roofing system manufacturer's representative; 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 new 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 Architect before proceeding.

B. Scheduling: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:

2. Schedule work to coincide with commencement of installation of new roofing system.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:

1. Certificate that installer is licensed to perform asbestos abatement.

B. Test and Evaluation Reports:

1. Fastener pull-out test report.

C. 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.

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

E. Qualification Statements for installer including certificate that Installer is licensed to perform asbestos abatement and is approved by warrantor of existing roofing system.

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:

1. Installer Qualifications: Minimum 5 years experience under current organizational structure.

a. Company: A qualified firm that is has specialized in removal of roofing similar to that required for this Project; who is approved, authorized, or licensed by roofing system manufacturer to perform the repair work as required to maintain any existing roof "CLOSEOUT PROCEDURES".

1.08 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Store roofing materials according to roofing system manufacturer's written instructions.
1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.

C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

D. Protect roofing 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.

1.09 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Perform roof removal only when existing and forecasted weather conditions permit work to proceed without water entering existing roofing system or building.
   2. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
   3. Provide temporary protection to prevent water from entering existing roofing system or building.
   4. Maintain continuous temporary protection prior to and during installation of new roofing system.

B. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.
   1. Coordinate work activities daily with Owner 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.
   2. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below the affected area. Verify that occupants below the work area have been evacuated before proceeding with work over the impaired deck area.
   3. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

C. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.

D. Limit construction loads on roof.

E. Hazardous Materials: Per Section "ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS."
   1. When removing roofing materials which contain asbestos containing material (ACM) as described in 29 CFR 1926.1101(g)(8)(ii), use the following practices as shown in Response Action Detail Sheets 74 and 75.
      a. Remove roofing material in an intact state.
      b. Use wet methods to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards.
      c. When removing built-up roofs, with asbestos-containing roofing felts and an aggregate surface, using a power roof cutter, collect dust resulting from the cutting operations by a HEPA dust collector, or by HEPA vacuuming along the cut line.
      d. Do not drop or throw asbestos-containing roofing material to the ground, but lower to the ground via covered, dust-tight chute, crane, hoist or other approved method.
      1) Lower ACM that is not intact to the ground as soon as practicable, but not later than the end of the work shift. While the material remains on the roof...
keep it wet or place in an impermeable waste bag or wrap in plastic sheeting.
2) Lower intact ACM to the ground as soon as practicable, but not later than the end of the work shift.
   e. Transfer unwrapped material to a closed receptacle.
   f. Place critical barriers over roof level heating and ventilation air intakes.

1.10 WARRANTY

A. Existing "CLOSEOUT PROCEDURES": Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.
   1. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE CRITERIA

A. General: Provide a watertight, roofing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and continued exposure to weather without failure.

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

C. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

2.03 MATERIALS

A. Temporary Protection: Sheet polyethylene or fiber reinforced plastic sheeting. Provide weights to retain sheeting in position.

B. Infill Materials: Match existing roofing system materials unless otherwise indicated or allowed.

C. Auxiliary Materials: Repair preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new roofing system.

D. Metal Flashing Sheet: Per Div. 07 Section "FLASHING AND SHEET METAL."

2.04 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are responsibilities of Contractor.
PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Protect existing roofing system that is indicated not to be reroofed.
   1. Loosely lay 1 inch minimum thick, expanded polystyrene (EPS) insulation over existing roofing in traffic and work areas. Loosely lay minimum 15/32 inch thick plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch.
   2. Limit traffic and material storage to areas of existing roofing that have been protected.
   3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of repairs.

C. Coordinate with Owner 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 roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing roofing system components that are to remain.

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

3.02 REMOVAL OF EXISTING ROOFING

A. Notify Owner each day of extent of roof tear off proposed for that day and obtain authorization to proceed.

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

C. Remove aggregate ballast and pavers from roof surface. Discard cracked pavers and store and protect undamaged pavers for reuse.

D. Remove accessories from roof if required to remove and replace roofing.

E. Partial Roof Tear Off: Remove indicated portions of existing roof system down to the deck. Remove no more existing roofing materials than can be replaced with new materials the same day, as weather permits.
   1. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
   2. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
   3. Remove fasteners from deck or cut fasteners off as close to deck surface as practicable.
3.03 REMOVAL OF EXISTING BASE FLASHINGS

A. Remove existing base flashings integral to area of roofing to be removed at vertical surfaces and penetrations.

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.

3.04 DECK AND PARAPET PREPARATION

A. Inspect deck and parapet after partial tear off of roofing system. Immediately notify Architect if the following conditions exist. Do not proceed with installation until directed by Architect.
   1. Broken or loose fasteners that secure deck panels to one another or to structure.
   2. Deck appears or feels inadequately attached.
   3. Deck surface is not suitable for receiving new roofing.
   4. Parapet sheathing exhibits deterioration or damage.
   5. Structural integrity of deck is suspect.

B. Provide additional deck securement as indicated on Drawings.

C. Advise Architect if any deck areas are deemed deteriorated beyond salvaging.

3.05 INFILL MATERIALS INSTALLATION

A. Immediately after removal of indicated portions of existing roofing system, and inspection and repair of deck, if needed, fill in the tear-off areas to match existing roofing system construction.
   1. Installation of infill materials is specified in Div. 07 Section "THERMOPLASTIC MEMBRANE ROOFING."
   2. Install new roofing membrane patch over infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

3.06 FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform inspections, perform field tests, and prepare reports.

3.07 CLEANING

A. Clean substrates of contaminants such as asphalt, adhesives, dirt, and debris.

B. Materials Ownership
   1. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials are Contractor's property and shall be removed from Project site.
   2. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
   3. Storage or sale of demolished items or materials on-site is not permitted.

C. Waste Management: Per Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."
SECTION 07 01 51.71 - ROOF REPAIRS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes repairs to and patching of existing roof system.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood blocking, curbs, cant, and nailers; and wood-based, structural-use roof deck panels.
   4. Div. 07 Section "SHEET METAL FLASHING AND TRIM" for metal roof penetration flashings, flashings, and counterflashings.
   5. Div. 07 Section "JOINT SEALANTS."
   6. Facility Services Subgroup Sections for roof drains.

1.02 REFERENCES

A. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. National Roofing Contractors Association (NRCA):

B. Definitions:
   1. Roofing Terminology: Definitions in the following apply to work of this Section:
      a. ASTM D 1079.
   2. Existing Roofing System: Includes roofing membranes, auxiliary roofing materials and accessories, substrate boards, vapor retarders, roof insulation, insulation accessories, cover board, ballast, roof pavers, walkway products, metal edging and flashing integral to the roof, metal copings protecting edges of roof, and other roofing components.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct meetings at Project site per Div. 01 Section "PROJECT MEETINGS."
   1. Attendees: Per Div. 01 Section "PROJECT MEETINGS." Include Owner's insurer if applicable, testing and inspecting agency representative.
   2. Review methods and procedures related to roofing system repairs including, but not limited to, the following:
      a. Preparation, including 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 repairs, and roof drain plugging and plug removal requirements.
d. Condition and acceptance of existing roof deck and base flashing substrate for reuse.

e. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect repairs.

f. HVAC shutdown and sealing of air intakes.

g. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.

h. Asbestos removal and discovery of asbestos-containing materials.

i. Governing regulations and requirements for insurance and certificates if applicable.

b. Existing conditions that may require notification of Architect before proceeding.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Certificate that installer is licensed to perform asbestos abatement and is approved by warrantor of existing roofing system.

B. Test and Evaluation Reports:
   1. Fastener pull-out test report.

C. 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 repair operations. Submit before Work begins.

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

E. Qualification Statements for installer including certificate that Installer is licensed to perform asbestos abatement and is approved by warrantor of existing roofing system.

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A qualified firm that is has specialized in installing roofing similar to that required for this Project; who is approved, authorized, or licensed by roofing system manufacturer to perform the repair work as required to maintain any existing roof "CLOSEOUT PROCEDURES".

1.08 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS"

B. Store roofing materials according to roofing system manufacturer's written instructions.
1. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
2. Do not leave unused felts and other sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F.
3. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.

C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

D. Protect roofing 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.

1.09 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Proceed with roof repair preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

B. Owner will occupy portions of building immediately below repair area. Conduct repairs so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.
1. Coordinate work activities daily with Owner 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.

C. Protect building to be repaired, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from repair operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Coordinate roof repair work with mechanical and electrical and other work requiring roof penetrations and subsequent repairs.

F. Schedule work to coincide with commencement of installation of new rooftop equipment.

G. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.

H. Provide protective devices to prevent water from entering existing roofing system or building.

I. Hazardous Materials: Per Section "ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS."
1. When removing roofing materials which contain asbestos containing material (ACM) as described in 29 CFR 1926.1101(g)(8)(ii), use the following practices as shown in Response Action Detail Sheets 74 and 75.
   a. Remove roofing material in an intact state.
   b. Use wet methods to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards.
c. When removing built-up roofs, with asbestos-containing roofing felts and an aggregate surface, using a power roof cutter, collect dust resulting from the cutting operations by a HEPA dust collector, or by HEPA vacuuming along the cut line.

d. Do not drop or throw asbestos-containing roofing material to the ground, but lower to the ground via covered, dust-tight chute, crane, hoist or other approved method.
   1) Lower ACM that is not intact to the ground as soon as practicable, but not later than the end of the work shift. While the material remains on the roof keep it wet or place in an impermeable waste bag or wrap in plastic sheeting.
   2) Lower intact ACM to the ground as soon as practicable, but not later than the end of the work shift.

e. Transfer unwrapped material to a closed receptacle.

f. Place critical barriers over roof level heating and ventilation air intakes.

J. Remove no more existing roofing materials than can be replaced with new materials the same day.

1.10 WARRANTY

A. Existing "CLOSEOUT PROCEDURES": Remove, replace, patch, and repair materials and surfaces cut or damaged during repairs, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.
   1. Notify warrantor of existing roofing system on completion of repairs, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE CRITERIA

A. General: Provide a watertight, roofing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and continued exposure to weather without failure.

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

C. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

2.03 MATERIALS

A. Temporary Protection: Sheet polyethylene or fiber reinforced plastic sheeting. Provide weights to retain sheeting in position.
B. Patching and Repair Materials: Match existing roofing system materials unless otherwise indicated or allowed.

C. Auxiliary Materials: Repair preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing roofing system.

D. Metal Flashing Sheet: Per Div. 07 Section "FLASHING AND SHEET METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verify that roof openings and penetrations are in place and set and braced.

C. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.

D. Protect existing roofing system that is indicated not to be replaced.
   1. Loosely lay 1-inch-minimum thick, expanded polystyrene (EPS) insulation over existing roofing in traffic and work areas. Loosely lay minimum 15/32-inch thick plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch.
   2. Limit traffic and material storage to areas of existing roofing that have been protected.
   3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of repairs.

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

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

G. Maintain roof drains in functioning condition to ensure proper 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 precipitation is forecast.
   1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing roofing system components that are to remain.

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

3.02 REMOVAL OF EXISTING ROOFING

A. Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.

B. Remove existing roofing and flashing as required to provide access for new deck penetrations. Remove aggregate surfacing, membranes, flashings, insulation, vapor retarders, and any other roof elements to expose structural deck.
1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
2. 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.

C. Inspect exposed substrates for deterioration and damage. Immediately notify Architect of findings.

D. Inspect and repair existing deck surface to provide smooth working surface for replacement roof system.

E. Provide temporary protective sheeting over exposed deck surfaces.

F. Turn protective sheeting up and over parapets and curbing. Retain sheeting in position with weights or temporary fasteners.

G. Provide for surface drainage from sheeting to existing drainage facilities.

3.03 ROOF REPAIRS

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

B. Patch roofing system according to roofing system manufacturer's written instructions and applicable recommendations of NRCA quality control guidelines applicable to the type of roofing encountered.

C. Immediately after removal of selected portions of existing roofing system, inspection and any necessary deck repair, fill in the tear-off areas to match existing roofing system construction. 1. Install new roofing the same day tear-off is made.

3.04 FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform inspections, and prepare reports.

3.05 CLEANING

A. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

B. Waste Management: Per Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."

END OF SECTION 07 01 51.71

07 01 51.71 - 6
ROOF REPAIRS
SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes thermal insulation for scheduled applications.

B. Products Specified in This Section for Installation Under Other Sections:
   1. Furnish board insulation for installation in masonry cavity walls under Div. 04 Section "COMMON WORK RESULTS FOR MASONRY."
   2. Furnish board insulation for installation as part of roofing system under Div. 07 "THERMOPLASTIC MEMBRANE ROOFING."

C. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 02-49 Sections specifying insulation by referencing this Section.
   4. Div. 09 Section "ACOUSTIC INSULATION" for sound-attenuating batts and blankets.
   5. Facility Services Subgroup Sections for insulation for fire-suppression, plumbing, and HVAC systems.

1.02 REFERENCES

A. Definitions:
   1. Mineral-Fiber Insulation: Insulation composed principally of fibers manufactured from rock, slag, or glass, with or without binders.
   2. Thermal Resistance R-Value: Aged value per inch of thickness at 5 years in deg F x h x sq. ft./Btu at 75 deg F.
   3. LTTR: Long-term thermal resistance per ASTM C1289.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate Work of this Section with work of other trades for proper time and sequence to avoid construction delays.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each type of insulation utilized showing locations of use. Identify material, type, thickness, and R-Value. Use same designations indicated on Schedule.
1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product certificates.

B. Test and Evaluation Reports:
   1. Research reports for foam-plastic insulation from ICC-ES showing compliance with building code in effect for Project.
   1. Product test reports for insulation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Delivery Requirements:
   1. Deliver materials and accessories in insulation manufacturer’s original packaging with identification labels intact and in sizes to suit project.
   2. Protect insulation from moisture exposure during delivery.
   3. Replace wet or damaged insulation materials.

C. Storage and Handling Requirements: Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
   1. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources.
   2. Store materials off ground in dry location and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   3. Store in original packaging until installed.
   4. Protect plastic insulation as follows:
      a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
      b. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
      c. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

1.07 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 DESCRIPTION

A. Insulation in forms and materials specified below for use to slow thermal transfer.
2.03 POLYSTYRENE FOAM BOARD INSULATION

A. Extruded-Polystyrene (XPS) Foam Board: ASTM C578 with either natural skin or cut cell surfaces as follows:
   1. Manufacturers:
      a. DiversiFoam Products.
      b. Dow Chemical Company (The).
      c. Kingspan Insulation, LLC.
      d. Owens Corning Foam Insulation, LLC.
      e. Pactiv Building Products.
      f. Comparable products by other manufacturers will be considered.
   2. Type: Type IV, 25 psi.
   4. Thermal Resistance: R-value 5 per inch.
   5. Surface-Burning Characteristics: ASTM E84; Class B.

2.04 POLYISOCYANurate FOAM BOARD INSULATION

A. Fiber Mat-Faced, Polyisocyanurate Board Roof Insulation: ASTM C 1289, Type II, Class 1, Grade 3 or Type II, Class 1, Grade 2, (except for dimensional stability and compressive strength), with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84. 
   1. Facers: Felt or glass-fiber mat facer on both major surfaces.
   2. Minimum Thickness: As indicated on Drawings.
   3. Minimum R-Value: 5.6 per inch per NRCA's predominant temperature condition-based design R-values.
   5. Dimensional Stability: 2 percent maximum linear change when conditioned at 158 degree F and 97 percent relative humidity for seven days.
   6. Curing time: 24 hours minimum, plus an additional 24 hours minimum per inch of thickness, at a minimum of 60 degree F before shipment from the manufacturer.
   7. Board Size: 4-foot by 4-foot maximum board size for insulation boards adhered to a substrate; 4-foot by 8-foot maximum board size for mechanically attached insulation boards.
   8. Individual Board Thickness: 2 inches maximum.
   9. Products:
      b. H-Shield-CG or H-Shield-AGF by Hunter Panels.
      c. UltraMax by Rmax, Inc.
      d. Comparable products by other manufacturers will be considered.

2.05 BATT/BLANKET INSULATION

A. Mineral-Wool Blanket: ASTM C665, Type I.
   1. Manufacturers:
      b. Owens Corning.
      c. Roxul Inc.
      d. Comparable products by other manufacturers will be considered.
   2. Facing: None.
   3. Thermal Resistance: R-value 4.2 per inch.
2.06 ACCESSORIES

A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

B. Spray Foam Joint, Crack, and Gap Filler: Low pressure, one component, expanding, closed-cell polyurethane foam compatible with insulation and adjacent surfaces; applied with professional hand-held dispensing gun; CFC and HCFC free; recommended by insulation manufacturer with demonstrated capability to bond to insulation and form a permanent airtight barrier.
   3. Comparable products by other manufacturers will be considered.

C. Adhered Insulation Fasteners:
   1. Manufacturers:
      a. AGM Industries, Inc.
      b. Gemco.
      c. Comparable products by other manufacturers will be considered.
   2. Spindle-Type Anchors: Adhesively attached plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
      a. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      b. Spindle: Same metal as plate; 0.106 inch in diameter; length to suit depth of insulation indicated, straight or angled as required.
   3. Insulation-Retaining Washers: Self-locking washers of same metal as plate, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
      a. Protect spindle ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
         1) Crawl spaces.
         2) Ceiling plenums.
         3) Attic spaces.
         4) Other locations where Owner's personnel may accidentally brush against spindles.
   4. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
   2. Verify substrate surfaces are flat, free of irregularities; materials or substances that may impede adhesive bond.
   3. Verify spaces are unobstructed to allow placement of insulation.
3.02 INSTALLATION, GENERAL

A. Comply with insulation manufacturer’s written instructions and recommendations applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer’s standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

E. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

3.03 INSTALLATION OF BELOW-GRADE INSULATION

A. Adhere insulation on vertical surfaces using manufacturer’s recommended adhesive per manufacturer’s written instructions.

1. If not otherwise indicated, extend insulation a minimum of 48 inches below exterior grade line.

2. Extend boards over expansion joints, unbonded on one side of joint.

3. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

4. Protect insulation from damage during backfilling.

3.04 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

A. Butt panels together for tight fit.

B. Adhesive Installation: Install with adhesive per manufacturer’s written instructions.

1. Install boards horizontally in running bond pattern.

2. Extend boards over expansion joints, unbonded on one side of joint.

C. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive per anchor manufacturer’s written instructions. Space anchors per insulation manufacturer’s written instructions for insulation type, thickness, and application indicated.

2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.

3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.05 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation
between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Install in running bond pattern.
2. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties or with plastic fasteners designed for this purpose and specified in Div. 04 Section "COMMON WORK RESULTS FOR MASONRY."

3.06 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Batt/Blanket Insulation: Install in cavities formed by framing members as follows:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation tight within spaces formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Extend insulation around cut openings, behind and around electrical and mechanical items within or behind partitions, and tight to items passing through partitions.
   4. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
   5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.

D. Sprayed Insulation: Apply sprayed insulation per manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
   1. Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.
   2. Spray insulation to envelop entire area to be insulated and fill voids.
   3. Apply in multiple passes to not exceed maximum thicknesses indicated and as recommended by manufacturer. Do not spray into rising foam.
   4. Miscellaneous Voids: Apply in miscellaneous voids and cavity spaces where required to prevent gaps in insulation per manufacturer's written instructions.

E. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
   1. Foamed-In-Place Insulation: Apply per manufacturer's written instructions.

3.07 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings per curtain-wall manufacturer's written instructions.
   1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to
3.07 THERMAL INSULATION

1. Hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation to fit snugly without bowing.

3.08 REPAIR

A. Remove and replace insulation materials that are damaged, wet, moisture damaged, and mold damaged.

3.09 CLEANING

A. Per Div. 01 Sections “CLOSEOUT PROCEDURES.”

3.10 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:
1. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
2. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.11 ATTACHMENTS

A. Schedule: Refer to separate “Thermal Insulation Schedule” for product types and thicknesses in each area of application.

END OF SECTION 07 21 00
### THERMAL INSULATION PRODUCT AND USAGE SCHEDULE

<table>
<thead>
<tr>
<th>Location</th>
<th>Material</th>
<th>Form</th>
<th>Facing</th>
<th>ASTM Compliance</th>
<th>Thickness</th>
<th>Min. R-Value</th>
<th>Support / Attachment / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABOVE GRADE FRAMED WALL CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal stud wall framing - 5-1/2 to 6 inch</td>
<td>Rock-wool, slag-wool</td>
<td>Blanket, mineral wool</td>
<td>Unfaced</td>
<td>ASTM C 665</td>
<td>As indicated</td>
<td>Varies / 4.2 per inch</td>
<td>Friction</td>
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<tr>
<td>ROOF</td>
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<td></td>
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</tr>
<tr>
<td>Under membrane roofing</td>
<td>Polysiocyanurate Type II, Class 1, Grade 3 or Type II, Class 1, Grade 2</td>
<td>Board, foam-plastic</td>
<td>Faced</td>
<td>ASTM C 1289</td>
<td>5.4 inch minimum</td>
<td>30</td>
<td>Mechanically fastened</td>
</tr>
</tbody>
</table>

PROVIDE INSULATION AS FOLLOWS:

Provide insulation of thicknesses scheduled above unless otherwise indicated on Drawings.

Where blanket insulation is indicated, provide blankets in batt or roll form with thermal resistances indicated.

Determine polyisocyanurate Insulation long term thermal resistance (LTTR) values in accordance with CAN/ULC S770.

END OF SCHEDULE 07 21 00.13
SECTION 07 24 00 - EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. EIFS-clad barrier soffit assemblies that are field applied over substrate.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 REFERENCES

A. Definitions:
   1. Definitions in ASTM E2110 apply to Work of this Section.
   2. EIFS: Exterior insulation and finish system(s).
   4. Polymer-Based Exterior Insulation and Finish System: Class PB EIFS, as defined in ASTM E2568.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each EIFS component, trim, and accessory.

B. Samples: For each type, texture, and color of exposed products for again for verification.
   1. Sample Size: 8 inches square.
   2. Include samples of exposed accessories involving color selection for initial selection.

1.06 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's certificates that EIFS complies with requirements, substrates are acceptable to EIFS manufacturer, and accessory products whether or not furnished by EIFS manufacturer and whether or not specified in this Section, are acceptable to EIFS manufacturer.
   2. Product certificates for accessory products installed with EIFS, including joint sealants, flashing, and trim.
   3. Product certificates for cementitious materials and aggregates and for insulation from manufacturer.
B. Sample warranties.

C. Quality Control Submittals: As follows
   1. Field quality control inspection reports.

D. Qualification Statements for installer.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

C. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.06 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An installer who is certified in writing by AWCI International as qualified to install Class PB EIFS using trained workers.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

C. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   1. Stack insulation board flat and off the ground.
   2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.
      a. Proceed with installation of adhesives or coatings only when ambient temperatures have remained, or are forecast to remain, above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after application. Do not apply EIFS adhesives or coatings during rainfall.
1.09 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 5 year warranty providing coverage against failures in materials or workmanship.
   1. Failures include, but are not limited to, the following:
      a. Bond integrity and weathertightness.
      b. Deterioration of EIFS finishes and other EIFS materials beyond normal weathering.
   2. Warranty coverage includes the following EIFS components:
      a. EIFS finish, including base coats, finish coats, and reinforcing mesh.
      b. Insulation installed as part of EIFS.
      c. Insulation adhesive and mechanical fasteners.
      d. EIFS accessories, including trim components and flashing.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. Dryvit Systems, Inc.
   2. Finestone; Degussa Wall Systems, Inc.
   3. Parex, Inc.; a brand of ParexLahabra, Inc.
   4. Senergy; Degussa Wall Systems, Inc.
   5. Sto Corp.
   6. TEC; an H. B. Fuller company.

B. Source Limitations: Obtain EIFS and DAFS through one source from a single manufacturer for entire Project, unless otherwise acceptable to Architect.
   1. Obtain secondary and incidental components from EIFS manufacturer or manufacturer approved by EIFS manufacturer as tested and compatible with EIFS components.

2.03 PERFORMANCE REQUIREMENTS

A. EIFS Performance: Comply with ASTM E2568 and with the following:
   1. Weathertightness: Resistant to water penetration from exterior.
   2. Structural Performance of Assembly and Components:
      a. Wind Loads: As indicated on Drawings.
   3. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch clean glass substrate; cured for 28 days and shows no growth when tested according to ASTM D3273 and evaluated according to ASTM D3274.

2.04 DESCRIPTION

A. EIFS soffit system consists of the following buildup:
   1. Fluid-applied flashing.
2. Trim accessories.
3. Mechanically fastened insulation.
4. Base coat.
5. Reinforcing-mesh.
6. Primer.
7. Finish coat.

2.05 EIFS MATERIALS

A. Fluid-Applied Flashing: Cold-applied; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.

B. Molded, (Expanded) Rigid Cellular Polystyrene Board Insulation: Comply with ASTM E2430/E2430M, unless otherwise noted, and the following:
   1. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, according to ASTM E84.
   2. Dimensions: Provide insulation boards of not more than 24 by 48 inches, with thickness indicated on Drawings.

C. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. according to ASTM E2098/E2098M and the following:
   1. Reinforcing Mesh for EIFS, General: Not less than weight required to comply with impact-performance level specified in "Performance Requirements" Article.
   2. Strip-Reinforcing Mesh: Not less than 3.75 oz./sq. yd..
   3. Detail-Reinforcing Mesh: Not less than 4.0 oz./sq. yd..
   4. Corner-Reinforcing Mesh: Not less than 7.2 oz./sq. yd..

D. Base Coat: EIFS manufacturer's standard mixture complying with one of the following:
   1. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
   2. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.

E. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners, consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; designed to resist Project's design loads; capable of pulling fastener head below surface of insulation board; and complying with the following:
   1. For attachment to steel studs from 0.033 to 0.112 inch in thickness, provide steel drill screws complying with ASTM C954.
   2. For attachment to light-gage steel framing members not less than 0.0179 inch in thickness, provide steel drill screws complying with ASTM C1002.

F. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

G. Finish Coat: EIFS manufacturer's siliconized acrylic-based coating complying with the following:
   1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
   2. Colors and Textures: As indicated or, if not indicated, as selected from manufacturer's full range.

H. Water: Potable.
I. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D1784 and ASTM C1063.
   1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
   2. Expansion Joint: Closed-cell polyethylene backer rod and elastomeric sealant, 3/4-inch minimum.

2.06 MIXING
   A. Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials, except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION
   A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
      B. Verification of Conditions:
         1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
         2. Examine flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.
         3. Proceed with installation only after unsatisfactory conditions have been corrected.
            a. Begin coating application only after surfaces are dry.
            b. Application of coating indicates acceptance of surfaces and conditions.
      C. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
      D. Protect EIFS, substrates, and construction behind them from inclement weather during installation. Prevent penetration of moisture behind EIFS and deterioration of substrates.
      E. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.02 EIFS INSTALLATION, GENERAL
   A. Comply with ASTM C1397, ASTM E2511, and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

3.03 SUBSTRATE PROTECTION APPLICATION
   A. Fluid-Applied Flashing: Apply to seal openings, penetrations, and terminations. Prime substrates with flashing primer if required and install flashing.
3.04 TRIM INSTALLATION

A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, and elsewhere as indicated. Coordinate with installation of insulation.
1. Expansion Joint: Use where indicated on Drawings.
2. Casing Bead: Use at other locations.

3.05 INSULATION INSTALLATION

A. Board Insulation: Mechanically attach insulation to substrate in compliance with ASTM C1397 and the following:
1. Mechanically attach insulation to substrate. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
   a. Steel Framing: 5/16 inch.
2. Apply insulation over dry substrates in courses, with long edges of boards perpendicular to framing.
3. Work from perimeter casing beads toward interior of panels if possible.
4. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
5. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
6. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch. Prevent airborne dispersal and immediately collect insulation raspings or sandings.
7. Interrupt insulation for expansion joints where indicated.
8. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between casing beads and between perimeter casing beads and adjoining surfaces of width indicated.
9. Before installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches over front and back face unless otherwise indicated on Drawings.
10. Treat exposed edges of insulation as follows:
   a. Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
   b. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
   c. At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.
11. Coordinate installation of flashing and insulation to produce soffit assembly that does not allow water to penetrate behind flashing and EIFS lamina.

B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
1. At expansion joints in substrates behind EIFS.
2. Where EIFS adjoins dissimilar substrates, materials, and construction, including other EIFS.
3. Where EIFS manufacturer requires joints in long continuous elevations.
3.06  BASE-COAT APPLICATION

A. Base Coat: Apply full coverage to exposed insulation with not less than 1/16-inch dry-coat thickness.

B. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners, overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C1397. Do not lap reinforcing mesh within 8 inches of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are invisible.

C. Additional Reinforcing Mesh: Apply strip-reinforcing mesh around openings, extending 4 inches beyond perimeter. Apply additional 9-by-12-inch strip-reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch-wide, strip-reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches on each side of corners.
   1. At aesthetic reveals, apply strip-reinforcing mesh not less than 8 inches wide.
   2. Embed strip-reinforcing mesh in base coat before applying first layer of reinforcing mesh.

3.07  FINISH-COAT APPLICATION

A. Primer: Apply over dry base coat.

B. Finish Coat: Apply full-thickness coverage over dry primed base coat, maintaining a wet edge at all times for uniform appearance, to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
   1. Embed aggregate in finish coat to produce a uniform applied-aggregate finish of color and texture matching approved sample.

3.08  FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform special inspections.

B. Special Inspections:
   1. As stipulated in Ch. 17 of the MBC.

C. EIFS will be considered defective if it does not pass inspections.

D. Prepare inspection reports.

3.09  CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

3.10  PROTECTION

A. Per Div. 01 Section "EXECUTION."
SECTION 07 24 23 - DIRECT-APPLIED FINISH SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes direct-applied finish system (DAFS).

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 05 Section "COLD-FORMED METAL FRAMING" for suspended metal framing.
   4. Div. 06 Section "SHEATHING" for glass-mat gypsum sheathing.
   5. Div. 07 Section "JOINT SEALANTS" for sealing joints in DAFS with elastomeric joint sealants.

1.02 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.03 ACTION SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Include plans, sections, details, penetrations, terminations, fasteners, and attachments to other work.

C. Samples for Initial Selection: For each type of finish-coat color and texture indicated.
   1. Include samples of exposed accessories involving color selection.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Maintenance Data: For DAFS to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Certified in writing by DAFS manufacturer to install manufacturer's system using trained workers.

B. Source Limitations: Obtain DAFS through one source from a single DAFS manufacturer and from sources approved by DAFS manufacturer as compatible with system components.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
C. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   1. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.07 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:

C. Weather Limitations: Maintain ambient temperatures above 40 deg F for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply DAFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit DAFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

D. Field Measurements: Verify actual dimensions required for prefabricated panels by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. Dryvit Systems, Inc.
   2. Finestone; Degussa Wall Systems, Inc.
   3. Parex, Inc.; a brand of ParexLahabra, Inc.
   4. Senergy; Degussa Wall Systems, Inc.
   5. Sto Corp.
   6. TEC; an H. B. Fuller company.
   7. Comparable products by other manufacturers will be considered.

B. Source Limitations: Obtain EIFS and DAFS through one source from a single manufacturer for entire Project, unless otherwise acceptable to Architect.
   1. Obtain secondary and incidental components from EIFS manufacturer or manufacturer approved by EIFS manufacturer as tested and compatible with EIFS components.

2.03 DESCRIPTION

A. Direct-applied finish system consists of direct-applied finish system (DAFS) without insulation direct-applied over glass-mat gypsum sheathing at rain-protected soffits and adjacent vertical surfaces including bulkheads.

2.04 PERFORMANCE / DESIGN CRITERIA

A. Class PB DAFS: Comply with performance characteristics in EIMA's "EIMA Guideline Specification for Exterior Insulation and Finish Systems, Class PB."
2. Positive and Negative Wind-Load Performance: Capability to withstand wind loads indicated when tested per ASTM E 330.


2.05 MATERIALS

A. Compatibility: Provide substrates, fasteners, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and approved for use by DAFS manufacturer for Project.

B. Primer/Sealer: Substrate conditioner designed to seal substrates from moisture penetration and to prepare substrate for application of finish coat.

C. Reinforcing Mesh: Balanced, alkali-resistant, open-weave glass-fiber mesh treated for compatibility with other DAFS materials and complying with EIMA 105.01 and ASTM D 578.
   1. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd.
   2. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd.
   3. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd.
   4. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd.

D. Base-Coat Materials: Standard mixture.

E. Primer: Factory-mixed elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

   1. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range.

G. Mechanical Fasteners: Corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener suitable for substrate.

H. Trim Accessories: Type as indicated or required to suit conditions and to comply with DAFS manufacturer's written requirements; manufactured from UV-stabilized PVC and complying with ASTM D 1784 and ASTM C 1063. Coordinate depth of trim and accessories with thicknesses of system required.
   1. Finish: Chemical-conversion coating, ASTM D 1730, Type B, compatible with field-applied finish coatings specified.
   2. Expansion Joint: Prefabricated one-piece V profile; designed to relieve stress of movement.
   3. Casing Bead: Prefabricated one-piece type of depth required to suit thickness of system.
   4. Manufacturers - Plastic Trim:
      a. Alabama Metal Industries Corporation (AMICO).
      b. Plastic Components, Inc.
      c. Vinyl Corp.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of DAFS.
C. Examine soffit framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where DAFS will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Begin coating application only after surfaces are dry.
   2. Application of coating indicates acceptance of surfaces and conditions.

E. Protect contiguous work from moisture deterioration and soiling caused by application of DAFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

F. Protect DAFS, substrates, and soffit construction behind them from inclement weather during installation. Prevent penetration of moisture behind DAFS and deterioration of substrates.

G. Prepare and clean substrates to comply with DAFS manufacturer's written instructions.

3.02 INSTALLATION

A. General: Comply with DAFS manufacturer's written instructions for installation of DAFS as applicable to each type of substrate indicated.

B. Trim Accessories: Apply trim accessories at perimeter of DAFS, at expansion joints, and elsewhere as indicated, according to DAFS manufacturer's written instructions.
   1. Expansion Joints: Install at locations indicated; where expansion joints are indicated in substrates behind DAFS; where DAFS adjoin dissimilar substrates, materials, and construction; and elsewhere as required by DAFS manufacturer.
   2. Casing Bead: Install at locations indicated; at system edge terminations; and elsewhere as required by DAFS manufacturer.
   3. Soffit Vent Screed: Install at locations indicated.

C. Base Coat: Apply to exposed surfaces of substrate in minimum thickness recommended in writing by DAFS manufacturer, but not less than 1/16-inch dry-coat thickness.

D. Reinforcing Mesh: Completely embed mesh in wet base coat, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.

E. Finish Coat: Apply over dry base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by DAFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.

F. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Div. 07 Section "JOINT SEALANTS" and in ASTM C 1481.
   1. Apply joint sealants after base coat has cured but before applying finish coat.
   2. Clean surfaces to receive sealants to comply with indicated requirements and DAFS manufacturer's written instructions.
   3. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
   4. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
   5. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
3.03 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. DAFS Tests and Inspections: For the following:

D. Remove and replace DAFS where test results indicate that DAFS do not comply with specified requirements.

E. Prepare test and inspection reports.

3.04 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Remove temporary covering and protection of other work. Promptly remove coating materials from other surfaces outside areas indicated to receive DAFS coatings.

END OF SECTION 07 24 23
SECTION 07 42 13.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes foamed-insulation-core metal wall panels.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 05 Section "COLD-FORMED METAL FRAMING" for cold-formed metal framing supporting metal wall panels.
   4. Div. 07 Section "FORMED METAL WALL PANELS" for concealed-fastened metal wall and soffit panels.
   5. Div. 07 Section "MODULAR METAL WALL PANELS" for modular-sized, concealed fastener, rainscreen wall panels.

1.02 DEFINITIONS

A. Metal Wall Panel Assembly: Insulated metal wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels including installers of doors, windows, and louvers.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
   6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   7. Review temporary protection requirements for metal wall panel assembly during and after installation.
   8. Review wall panel observation and repair procedures after metal wall panel installation.

B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wall panel and accessory.

A. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop-, and field-assembled work.
   1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
      a. Flashing and trim.
      b. Anchorage systems.

B. Samples: For each type and color of exposed products for verification.
   1. Sample Size:
      b. Trim and Accessory Samples: 12 inches in length for linear materials.
      c. Panel Profile Samples: 12 inches long by actual panel width of each panel profile in predominant color specified.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Exterior elevations, drawn to scale, and coordinating penetrations and wall-mounted items. Show the following:
   1. Wall panels and attachments.
   2. Stud framing.
   3. Wall-mounted items including doors and lighting fixtures.
   4. Penetrations of wall by pipes and utilities.

B. Test and Evaluation Reports:
   1. Product test reports for metal panels.

C. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranty per Div. 01 Section "CLOSEOUT PROCEDURES."

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.

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INSULATED METAL WALL PANELS
1.08 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Deliver metal wall panels, trim components, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.

C. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Retain strippable protective covering on metal wall panels for period of metal wall panel installation.

1.09 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:

B. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed per manufacturers' written instructions and warranty requirements.

1.10 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard 2 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Structural failures, including rupturing, cracking, or puncturing.
   2. Deterioration of metals and other materials beyond normal weathering.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 DESCRIPTION

A. Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed-in-place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

2.03 PERFORMANCE / DESIGN CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design metal wall panel assembly using performance requirements and design criteria specified herein.

B. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Performance Requirements: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing per ASTM E72, ASTM E330 or ASTM E1592:
   1. Design Wind Loads: As indicated on Drawings.
   2. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 of the span.

D. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
   3. Radiant Heat Exposure: No ignition when tested per NFPA 268.
   5. Surface-Burning Characteristics of Foam Core: ASTM E 84; Class A.

E. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested per ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft.

F. Water Penetration under Static Pressure: No water penetration when tested per ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft.

G. Thermal Performance Requirements:
   1. Provide metal panels that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Do not transmit thermal movement from metal wall panel components to adjacent building elements without prior written authorization from Architect.
3. R-Value: 14 when tested per ASTM C 518.

2.04 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
   1. Basis-of-Design Product: CENTRIA Architectural Systems; Versawall V+ or a comparable product by one of the following:
      a. Kingspan Group.
      b. MBCI.
      c. Metecno-Aluma Shield, Metecno Panel Systems, Inc.
      d. Metl-Span.

2. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
   a. Exterior Material: Zinc-coated (galvanized) steel sheet, 0.034 inch (22 ga.) nominal thickness.
      1) Exterior Surface: Flat, smooth metal sheet.
   b. Interior Material: Zinc-coated (galvanized) steel sheet, 0.022 inch (26 ga.) nominal thickness.

3. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent.
   a. Closed-Cell Content: 90 percent when tested per ASTM D 6226.
   b. Density: 2.0 to 2.6 lb/cu. ft. when tested per ASTM D 1622.
   c. Compressive Strength: Minimum 20 psi when tested per ASTM D 1621.
   d. Shear Strength: 26 psi when tested per ASTM C 273/C 273M.

5. Panel Thickness: 2 inches.

2.05 MATERIALS

A. Panel Face and Back Sheets: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A 755M.
   1. Surface: Smooth finish.

B. Panel Sealants: Compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads and as recommended by panel and fastener manufacturers. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
   1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
E. Flashing and sheet metal: Provide flashing and trim formed from metal of thickness to match panel facing. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, copings, parapet caps, fasciae, corner units, soffits, bases, framed openings, sills, jambs, drips, and fillers. Finish flashing and sheet metal with same finish system as adjacent metal wall panels.
   1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

F. Panel Accessories: Provide components required for a complete metal wall panel assembly including sealants, gaskets, fillers, closure strips, and similar items. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
   1. Where exposed, match material and finish of metal wall panels unless otherwise indicated.
   2. Provide manufacturer's extruded trim shapes where noted.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1 inch thick, flexible closure strips; cut or preformed to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

2.06 FABRICATION

A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication, and indicate measurements on Shop Drawings.

C. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

D. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

E. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

F. Flashing and sheet metal: Comply with Div.07 Section "FLASHING AND SHEET METAL," metal panel manufacturer's recommendations.
   1. Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   2. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.07 METAL PANEL COIL-COATED FINISHES

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

B. Exterior Panel Facing and Trim Finish:
   1. Superior-Performance Organic Finish: AAMA 621 PVDF fluoropolymer superior performance coil coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

C. Interior Panel Facing Finish: Manufacturer's standard siliconized polyester.

D. Concealed Internal Panel Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
   1. Examine wall framing to verify that studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
   2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

C. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

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

E. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

3.02 METAL PANEL INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.
B. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to support framing unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Do not begin installation until air-barriers and flashings that will be concealed by metal wall panels are installed.
   2. Shim or otherwise plumb substrates receiving metal wall panels.
   3. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   4. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.

C. Fasteners:
   1. Fasten metal wall panels to supports with fasteners or concealed clips at each joint at location and spacing. Fully engage tongue and groove of adjacent panels.
      a. Install clips to supports with self-tapping fasteners.
   2. Install screw fasteners in predrilled holes.
   3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
   4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washers.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Install sheet metal flashing and trim to fit substrates with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
   2. Install flashing and trim as metal wall panel work proceeds.
   3. Flash and seal metal wall panels with weather closures at perimeter edges and openings.
   4. Fasten with self-tapping screws, concealed where possible.
   5. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
   6. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

E. Joint Sealers and Accessories: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies.
   1. Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   2. Prepare joints and apply sealants to comply with requirements in Div. 07 Section "JOINT SEALANTS."
   3. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel.
      a. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
   4. Seal side joints where recommended by metal wall panel manufacturer.
5. Seal between metal base channel (sill angle) and adjacent construction, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.

6. Apply a continuous ribbon of sealant tape between panels and protruding equipment, vents, and accessories, and elsewhere as needed to make panels weathertight.

3.03 REPAIR

A. Repairing Damaged Finishes: Immediately after installation, clean abraded and other areas where coatings are damaged.
   1. Galvanized Surfaces: Repair per Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."
   2. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish per manufacturer's written instructions.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures to Architect's and Owner's satisfaction.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions.

C. On completion of metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant and clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

3.05 PROTECTION

A. Per Div. 01 Section "EXECUTION."

END OF SECTION 07 42 13.19
SECTION 07 42 13.26 - MODULAR METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes modular-sized, concealed fastener, rainscreen wall panels.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Section "FORMED METAL WALL PANELS" for concealed-fastener metal wall panels and metal soffit panels.
   4. Div. 07 Section "INSULATED METAL WALL PANELS" for foamed-insulation core, laminated-insulation core, and honeycomb-core metal wall panels.
   5. Div. 07 Section "FLASHING AND SHEET METAL" for standards and for flashings and other sheet metal work not part of modular metal wall panel assemblies.

1.02 REFERENCES

A. Definitions:
   1. Modular Metal Wall Panel Assembly: Modular-sized, concealed fastener, rainscreen wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete rainscreen wall system.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   a. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, modular metal wall panel installer, modular metal wall panel manufacturer's representative, structural-support installer, and installers whose work interfaces with or affects modular metal wall panels including installers of doors, windows, and louvers.
   b. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   c. Review methods and procedures related to modular metal wall panel installation, including manufacturer's written instructions.
   d. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   e. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect modular metal wall panels.
   f. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   g. Review temporary protection requirements for modular metal wall panel assembly during and after installation.
   h. Review wall panel observation and repair procedures after modular metal wall panel installation.
   i. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

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MODULAR METAL WALL PANELS
B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate modular metal wall panel assemblies with flashing, trim, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show fabrication and installation layouts of modular metal wall panels; details of edge conditions, dimensions of individual components and profiles, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, accessories, special details, and finishes. Distinguish between factory-, shop-, and field-assembled work.
   2. Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
      a. Flashing and trim.
      b. Anchorage systems.
   3. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      a. Wall panels and attachments.
      b. Stud framing.
      c. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
      d. Penetrations of wall by pipes and utilities.

C. Samples: For each type and color of exposed products for verification.
   1. Sample Size:
      a. 12 inches square for sheet materials.
      b. 12 inches in length for linear materials.
   2. Metal panel with specified finish applied.
   3. Trim and Closures: Include fasteners and other exposed accessories.
   5. Assembly Sample: 18 inches square including a four-way joint, fasteners, closures, and other modular metal wall panel accessories.

1.06 INFORMATIONAL SUBMITTALS

A. Sample warranties.

B. Quality Control Submittals: As follows
   1. Field quality control inspection reports.

C. Qualification Statements for installer,

1.07 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

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MODULAR METAL WALL PANELS
1.08 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An employer of workers and supervisors trained and approved by manufacturer for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Deliver components, sheets, modular metal wall panels, and other manufactured items so as not to be damaged or deformed. Package modular metal wall panels for protection during transportation and handling.

C. Unload, store, and erect modular metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Stack modular metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store modular metal panels to ensure dryness, with positive slope for drainage of water. Do not store modular metal panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Retain strippable protective covering on modular metal wall panel for period of panel installation.

1.10 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard 2 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Structural failures, including rupturing, cracking, or puncturing.
   2. Deterioration of metals and other materials beyond normal weathering.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.
B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

   1. Substitutions will be considered. Comply with provisions of Div. 01 Section "SUBSTITUTION PROCEDURES."

2.03 DESCRIPTION

A. Modular metal wall panel system consisting of aluminum panels in a rainscreen application as part of the assembly described below:

B. Modular metal wall panel assemblies used as an exterior wall finish and architectural trim consist of aluminum wall panels formed into modular shapes for rainscreen installation method including attachment assembly components, and accessories required for a complete system.
   1. Attachment Assembly: Rainscreen principle system.

2.04 PERFORMANCE / DESIGN CRITERIA

A. General Performance: Modular metal wall panel assemblies shall comply with performance requirements without failure.

B. Structural Performance Requirements: Provide modular metal wall panel assemblies, including anchorages, installed over indicated wall system capable of withstanding, without failure due to defective manufacture, fabrication, installation, or other defects in construction, the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
   1. Design Wind Loads: As indicated on Drawings.
   2. Deflection Limits: For wind loads, horizontal deflection no greater than 1/175 of the span at the perimeter and 1/60 of the span anywhere in the panel.

C. Thermal Performance Requirements:
   1. Provide modular metal assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, reduction of performance, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.05 MODULAR METAL WALL PANELS

A. Modular Metal Wall Panels: Factory-formed and -assembled, panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core.
   1. Metal Facing: Aluminum sheet, 0.060 inch thick.
   4. Panel Flatness: Maximum allowable distortion of 1/32 inch in 24 inches in any direction. Panel lines, breaks, and angles shall be sharp and true, and surfaces shall be free from warp or buckle.
   5. Clips: Manufacturer's standard clips as required to meet performance requirements.
   7. Panel Sizes: As indicated on drawings.
2.06 MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   1. Surface: Smooth, flat finish.

B. Miscellaneous Metal Framing Components: Cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating.
   1. Hat Channels: 0.048 inch/18 ga. minimum nominal thickness.
   2. Sill Channels: 0.048 inch/18 ga. minimum nominal thickness.

C. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Where exposed, match material and finish of modular metal panels, unless otherwise indicated.

D. Flashing and Trim: Provide flashing and trim formed from same material and thickness as modular metal panels as required to seal against weather and to provide finished appearance. Finish exposed flashing and trim with same finish system as adjacent modular metal panels.

2.07 FABRICATION

A. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before modular metal wall panel fabrication and indicate measurements on Shop Drawings.

B. General: Fabricate and finish modular metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

C. Modular Metal Wall Panels: Factory fabricate modular metal panels requiring no further fabrication or modification in field.
   1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
   2. Fabricate panels with sharply cut edges.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA’s "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

2.08 FACE FINISH, GENERAL REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.
B. Protect mechanical and painted 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.

2.09 ALUMINUM FINISH

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Exposed Coil-Coated Finishes:
   1. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section “SHOP-APPLIED PAINT COATINGS FOR METAL.”

C. Concealed Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, modular metal wall panel supports, and other conditions affecting performance of the Work.
   1. Examine wall framing to verify that panel support members and anchorage have been installed within alignment tolerances required by modular metal wall panel manufacturer.
      a. Maximum deviations acceptable to modular metal panel system manufacturer:
         1) 1/4-inch in 20 feet vertically or horizontally from face plane of framing.
         2) 1/2-inch maximum deviation from flat substrate-on any building elevation.
         3) 1/8-inch in 5 feet.
   2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by modular metal wall panel manufacturer.
   3. Verify that air barrier has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

C. Examine roughing-in for components and systems penetrating modular metal wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by modular metal wall panel manufacturer.

E. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 MODULAR METAL WALL PANEL INSTALLATION

A. Installation: Attach panels to metal sub-framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
   1. Horizontal Joinery: Working from base of installation to top, connect upper panel to lower panel at joinery.
   2. Vertical Joinery: Provide reveal between vertical ends of panels as shown on shop drawings.
   3. Galvanic Action: Where elements of modular metal wall system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

B. Rainscreen Installation: Proceed with installation of manufacturer's dry seal horizontal joinery. Keep open spaces in horizontal joinery intended to ventilate cavity behind system.

3.03 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align modular metal wall panel units within installed tolerance of 1/4 inch in 20 feet, non-cumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.04 FIELD QUALITY CONTROL

A. Manufacturer Services:
   1. Require product manufacturers to inspect completed modular metal wall panel installation, including accessories at completion of installation.

3.05 CLEANING

A. Per Div. 01 Section "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary protective coverings and strippable films, if any, as modular metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of modular metal wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

C. After modular metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

D. Replace modular metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13.26
SECTION 07 42 13.53 - METAL SOFFIT PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes metal soffit panels.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Coordinate metal panel installation with flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples: For each type and color of exposed products for verification.
   1. Finish Sample Size: Not less than 4 inches square.

1.05 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."
1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

C. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

B. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

C. Retain strippable protective covering on metal panels during installation.

1.06 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 2 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Structural failures including rupturing, cracking, or puncturing.
   2. Deterioration of metals and other materials beyond normal weathering.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Basis of Design Product: Wind-Lok® Soffit Panel (MPS120 Solid and MPV120 Vented) by ATAS International, Inc. or a comparable product by one of the following:
   1. ATAS International, Inc.
   2. Berridge Manufacturing Company.
   3. Dimensional Metals, Inc.
   4. Englert, Inc.
   5. Fabral.
   7. McElroy Metal, Inc.
2.03 DESCRIPTION

A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

2.04 PERFORMANCE CRITERIA

A. General Performance: Metal soffit panel assemblies shall comply with performance requirements without failure.

B. Structural Performance: Provide metal soffit panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
   1. Design Wind Loads: As indicated on Drawings.
   2. Deflection Limits: For wind loads, no greater than 1/240 of the span.

C. Thermal Performance Requirements:
   1. Provide metal soffit panel assemblies that allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.05 METAL SOFFIT PANELS

A. Profile: Solid and perforated panels formed with interlocking hooked panel edges with a trapezoidal V-groove joint between panels.
   1. Panel Coverage: 12 inches.
   2. Panel Height: 3/8 inches.

B. Material: Metallic-coated steel sheet.

C. Finish: As indicated or, if not indicated, as selected from manufacturer's full range.

D. Sealant: Factory applied within interlocking joint.

2.06 MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) steel sheet with Class G90 coating designation or ASTM A 792/A 792M aluminum-zinc alloy-coated (Galvalume®) steel sheet with Class AZ50 coating designation, structural quality with smooth, flat surface; finished per ASTM A 755/A 755M as follows:
   1. Nominal Thickness: 0.024 inch.
   2. Exterior Finish: Superior-performance organic finish per Div. 05 Section “SHOP-APPLIED PAINT COATINGS FOR METAL.”
   3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
2.07 MISCELLANEOUS MATERIALS

A. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

D. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
   2. Sealant: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

2.08 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer’s standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including intermediate stiffening ribs for full length of panel.

C. Flashing and Sheet Metal: Fabricate flashing and trim to comply with manufacturer’s recommendations, Div. 07 Section "FLASHING AND SHEET METAL," and recommendations in SMACNA’s "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA’s "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.09 FINISHES

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

07 42 13 - 4 METAL SOFFIT PANELS
B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine conditions with installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
      a. Verify that air-barriers, if any, have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
   3. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air-resistive barrier, if any, and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
   8. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

B. Fasteners:
   1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Panels: Fasten metal panels to supports with concealed fasteners at each interlocking joint at location and spacing recommended by manufacturer.
   1. Apply panels and associated items true to line for neat and weathertight enclosure.
   2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
   3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

D. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

E. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, Div. 07 Section "FLASHING AND SHEET METAL," and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install flashing and sheet metal to fit substrates and to achieve waterproof performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.03 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

3.04 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13
SECTION 07 54 00 - THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes PVC roofing system applied by fully adhered method.

B. Products Specified in Other Sections for Installation Under This Section:
   1. Install roof insulation specified in Div. 07 Section "THERMAL INSULATION."
   2. Sheet metal flashing and trim for roofing applications specified in Div. 07 Section "SHEET METAL FLASHING AND TRIM."
   3. Roof-mounted curbs, and equipment-support rails for roofing applications specified in Div. 07 Section "ROOF ACCESSORIES."
   4. Joint sealants, joint fillers, and joint preparation specified in Div. 07 Section "JOINT SEALANTS."

C. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood nailers, curbs, and blocking.
   4. Div. 06 Section "SHEATHING" for wood-based, structural-use roof deck panels.
   5. Div. 07 Section "PREPARATION FOR RE-ROOFING" for roof tear-off work preceding new roofing.
   6. Div. 07 Section "FLASHING AND SHEET METAL" for metal roof flashings and counterflashings.
   7. Div. 07 Section "JOINT SEALANTS" for joint sealants, joint fillers, and joint preparation.

1.02 REFERENCES

A. Definitions:
   1. PVC: Polyvinyl-chloride.
   2. Roof System: Includes roofing membranes, auxiliary roofing materials and accessories, substrate boards, vapor retarders, roof insulation, insulation accessories, cover board, metal edging and flashing integral to the roof, metal copings protecting edges of roof, and other roofing components.
   3. Roofing Terminology: Definitions in the following apply to work of this Section:
      a. ASTM D 1079.
      b. Appendix A Glossary of Terms in FM Global's "Roof Systems" 1-28R / 1-29R.

B. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. Factory Mutual (FM Global):
      a. 1-29: Roof Deck Securement and Above-Deck Roof Components.
   3. National Roofing Contractors Association (NRCA):

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct meetings at Project site per Div. 01 Section "PROJECT MEETINGS."

B. Coordination: Coordinate Work of this Section with Facility Services Subgroup Sections (Div. 20-29) specifying rooftop-mounted equipment.

B. Preliminary Meeting: Conduct minimum one week prior to starting roof deck construction.
1. Attendees and Agenda: Same as Preinstallation Meeting below.
2. Review deck substrate requirements for conditions and finishes, including flatness and fastening.

C. Preinstallation Meeting: Conduct minimum one week prior to commencing work of this Section.
1. Attendees: Per Div. 01 Section "PROJECT MEETINGS," Include Owner's insurer if applicable, testing and inspecting agency representative.
2. Attendees: Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
3. Agenda:
   a. Review approved submittals for the roof system.
   b. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
   c. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   e. Review structural loading limitations of roof deck during and after roofing.
   f. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
   g. Review governing regulations and requirements for insurance and certificates if applicable.
   h. Review temporary protection requirements for roofing system during and after installation.
   i. Review roof observation and repair procedures after roofing installation.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include:
1. Roof plan showing orientation of steel roof deck, fastening spacings, and tapered insulation plan, including slopes, crickets, saddles, and tapered edge strips.
2. Base flashing and membrane termination details.
3. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
C. Samples: For each type and color of the following for verification.
   1. Sheet roofing; 12 inches square.

1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's certificates.
   2. Material certificates.
   3. Manufacturer's field representative's certificate.

B. Test and Evaluation Reports: As follows:
   1. Research/evaluation reports for components of roofing system, from ICC-ES.

C. Sample warranties.

D. Quality Control Submittals: As follows
   1. Field quality control test and inspection reports.

E. Manufacturer reports.

F. Preconstruction photographs or video per Div. 01 Section "PHOTOGRAPHIC DOCUMENTATION."

G. Qualification Statements for manufacturer and installer.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: A qualified manufacturer that is UL listed and FM Global approved for roofing system identical to that used for this Project.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
      b. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   3. Contractor's Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS"
   4. Manufacturer's Technical Representative Qualifications: Minimum 5 years experience with manufacturer of Products specified in this Section.

B. Certifications: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's field representative's certificate of compliance.
   2. Material certificates for membranes, flashings, insulation, fasteners, and adhesives.

C. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
1. In areas where insulation is to be adhesive-applied, test insulation adhesion per ANSI/SPRI IA-1.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Include date of manufacture and approval or listing agency markings on containers.
   2. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

B. 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.

C. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

D. 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.

1.09 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:

B. Weather Conditions: Perform installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.10 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Special Warranty: Furnish manufacturer's standard 20 year warranty without monetary limitation (no dollar limit) with the following provisions:
   1. Manufacturer's warranty includes roof system as defined herein.
   2. Failure includes roof leaks and wind damage caused by wind speeds less than or equal to 110 miles per hour; hail damage from hailstones up to and including 1-1/5 inch diameter.
   3. Include coverage for accidental punctures for up to 16 billed repair hours per year for the term of the warranty.

C. Special Warranty: Furnish installer's 2 year warranty on special form specified at end of Section containing the following terms and Conditions:
   1. Installer's warranty includes roof system as defined herein.
D. Extended Correction Period: Extend correction period for roof system to 2 years.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Project Source Limitations: Obtain each roof system component, whether specified in this Section or in other Sections, from membrane roofing manufacturer or manufacturer approved by membrane roofing manufacturer.

B. System Source Limitations: Roofing is designed as a system. Assign responsibility for installation of the roof system to a single qualified roof installer who is capable of showing prior successful installation of systems similar to that required.
   1. Roof system products include, but are not limited to, products specified in this Section and the following Sections as they apply to the roof:
      a. Div. 07 Section "PREPARATION FOR RE-ROOFING."
      b. Div. 07 Section "ROOF REPAIRS."
      c. Div. 07 Section "FLASHING AND SHEET METAL" related to roofing.
      d. Div. 07 Section "ROOF ACCESSORIES."
      e. Div. 07 Section "JOINT SEALANTS."

2.03 DESCRIPTION

A. Roof system consists of a single-ply of PVC membrane applied by fully adhered method on cover board, on insulation, on vapor retarder, on substrate board, on existing or new deck substrates. Deck substrates include metal deck, concrete deck, and gypsum deck. Roof system includes, but is not limited to, substrate board, vapor retarder, roof insulation, cover boards, fasteners, adhesives, roofing membrane, base flashings, roofing membrane accessories, metal edging and flashing integral to the roofing system, metal copings protecting edges of roofing system, and other components of roofing system.

2.04 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of referenced standards and the following:

B. General Performance: Provide roof system capable of withstanding, without failure, the effects of specified uplift pressures, thermally induced movement, and exposure to weather. Roof system shall remain watertight.
   1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
   2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

C. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
D. Roofing System Design: Provide roof system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist design wind uplift pressures.
   1. Design Wind Uplift Pressures:
      a. Zone 1 (Field): -34 psf
      b. Zone 2 (roof edge 10 feet wide): -55 psf
      c. Zone 3 (roof corners 10 feet wide): -82 psf

E. FM Global Listing: Provide roof system that complies with requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and that is listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
   1. Fire/Windstorm Classification: Class 1A-90.
   2. Hail-Resistance Rating: SH.

F. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

G. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency for fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.05 PVC ROOFING

A. PVC Sheet: ASTM D 4434/D 4434M, Type III.
   1. Manufacturers:
      a. Carlisle SynTec Incorporated.
      b. Duro-Last Roofing, Inc.
      c. GAF Materials Corporation.
      d. GenFlex Roofing Systems.
      e. Johns Manville.
      f. Comparable products by other manufacturers will be considered.
   2. Thickness: 60 mils, nominal.

2.06 AUXILIARY ROOFING MATERIALS

A. General: Provide auxiliary materials as recommended by roofing system manufacturer for intended use and compatible with roofing.

B. Bonding Adhesive: Manufacturer's standard.

C. Metal Termination Bars: Predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; predrilled at 9 inch centers with anchors.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

E. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.
   1. Provide flashing in color to match roof membrane.
2.07 SUBSTRATE BOARDS

A. Gypsum Board roof sheathing as specified in Div. 06 Section "SHEATHING."

B. Substrate Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate panel to roof deck.

2.08 VAPOR RETARDER

A. Self-Adhering-Sheet Vapor Retarder: ASTM D 1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

2.09 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Board Insulation: Per Div. 07 Section "THERMAL INSULATION."

C. Tapered Insulation: Provide matching factory-tapered insulation boards fabricated to provide minimum 1/4 inch per foot slope to drain relative to dead level.
   1. Provide at dead level surfaces to create slope to drain.
   2. Provide preformed saddles to direct water flow to drains.
   3. Provide preformed crickets to create reverse slope at vertical obstructions to water flow.
   4. Provide tapered edge strips, and other insulation shapes as indicated or required to ensure water flow to drains.

2.10 INSULATION ACCESSORIES

A. General: Provide roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
   1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive or full-spread spray-applied, low-rise, two-component urethane adhesive as recommended by roofing system and insulation manufacturers.

2.11 COVER BOARD

   1. Thickness: 1/2 inch.
   2. R-Value: 0.5
   4. Products:
PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
   2. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
   3. Verify that wood nailers, blocking and curbs and are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   4. For Steel Roof Decks: Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Div. 05 Section "STEEL DECKING."
      a. Verify that steel roof deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
   5. For Concrete Roof Decks:
      a. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      b. Verify that compounds that will impair adhesion of roofing components to roof deck have been removed.
      c. Verify adjacent precast concrete roof members do not vary more than 1/4 inch in height. Verify grout keys are filled flush.
   6. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
   7. Proceed with installation only after unsatisfactory conditions have been corrected.

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

D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.02 ROOFING INSTALLATION, GENERAL

A. Comply with roofing system manufacturer's written installation instructions and recommendations and approved submittals.

B. Unroll roofing membrane and allow to relax before installing.

C. Accurately align roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Apply roofing with side laps shingled with slope of roof deck where possible.

E. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of each workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
F. Install roofing and auxiliary materials to tie in to existing roofing, to maintain weathertightness of transition, and to not void warranty for existing roofing system.

G. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.03 SUBSTRATE BOARD INSTALLATION

A. Install substrate board on metal deck with long joints perpendicular to flutes in continuous straight lines; support and stagger end joints. Tightly butt substrate boards together. Cut substrate boards cleanly and accurately at roof breaks and protrusions to provide smooth surface.

1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions and according to recommendations in FM Global's “RoofNav” and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

3.04 VAPOR-RETARDER INSTALLATION

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

1. Extend vapor retarder under cant strips and blocking to deck edge.

2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

C. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

3.05 INSULATION INSTALLATION

A. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

B. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

C. 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.

D. On metal deck, place boards with long edges perpendicular to flutes with board ends bearing on deck flutes

E. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards.

F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof. Fill gaps exceeding 1/4 inch with insulation.
1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
2. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

G. Install tapered insulation to conform to slopes indicated. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 24 inches.
   1. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

H. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   1. Fasten first layer of insulation according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
   2. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive or in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.06 COVER BOARD INSTALLATION

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.
   1. Fasten cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.

3.07 FULLY-ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions.

B. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

C. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeters.

3.08 SEAMING METHOD

A. PVC Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

A. Leave seams exposed until inspected by roofing system manufacturer and testing agency.

3.09 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.10 FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform inspections, perform field tests, and prepare reports.
   1. Electric Field Vector Mapping (EFVM): Testing agency shall survey entire roof area for potential leaks using electric field vector mapping (EFVM).

C. Field Tests: Arrange for assistance of a factory-authorized service representative.
   1. Insulation Adhesion Testing: In areas where insulation is to be adhesive-applied, test insulation adhesion per ANSI/SPRI IA-1.

D. Field Inspections:
   1. Evaluate installer's quality-control methods.
   2. Periodic Inspections: Inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components.
      a. Schedule periodic site visits to review work at the following times:
         1) After delivery and storage of products and after preparatory work on which work of this Section depends is complete, but before installation begins.
         2) Twice during progress of work at 25% and 60% complete.
         3) Upon completion of work, after cleaning is carried out.
      b. Monitor and report installation procedures, weather and temperature conditions, and unacceptable conditions.
      c. Prepare and submit reports of each job site inspection to keep the Architect and Owner informed as to the progress and quality of the roofing work as observed.
      d. Immediately report to the Architect and Owner by phone and in writing any failure or refusal of the installer to correct unacceptable practices called to the installer's attention.
      e. Accompany roofing system manufacturer's technical personnel during the final roof inspection.
      f. Report, after completion of roofing and related work, any deviations from products or application procedures specified, other than those that may have been previously reported and corrected or accepted by the Architect and Owner.

E. Manufacturer Services:
   1. Require product manufacturers to provide periodic field surveillance of the handling, installation/application, protection and cleaning of their products.
   2. Schedule periodic site visits to review work at the following times:
      a. After delivery and storage of products and after preparatory work on which work of this Section depends is complete, but before installation begins.
3. Monitor and report installation procedures, weather and temperature conditions, and unacceptable conditions.
   a. Prepare and submit reports of each job site inspection to Contractor with copy to Architect to keep the Architect and Owner informed as to the progress and quality of the roofing work as observed.

4. Final Roof Inspection: Inspect roofing installation on completion and prepare a written report to Contractor with copy to Architect describing nature and extent of poor workmanship, deterioration, or damage found in the work.
   a. Notify Architect and Owner 48 hours in advance of date and time of inspection.

5. Annual Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation not less than once per year during the warranty period, and submit report to Owner verifying continuing coverage of roof for remainder of specified warranty program.
   a. Notify Owner 72 hours in advance of date and time of annual roof inspection.

F. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   B. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 PROTECTION

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
   B. Correct deficiencies in or remove membrane roofing system that do not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.13 ATTACHMENTS

A. Roofing Installer's Warranty.

END OF SECTION 07 54 00
ROOFING INSTALLER'S WARRANTY

WHEREAS ______________________ (Installer's name)
of ______________________ (Installer's address),
herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

Owner: ______________________ (Owner's name)
Address: ______________________ (Owner's address)
Building Name/Type: ______________________ (Insert information)
Address: ______________________ (Insert address)
Area of Work: ______________________ (Insert information)
Acceptance Date: ______________________
Warranty Period: ______________________ (Insert time)
Expiration Date: ______________________

AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period, NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by: a) lightning; b) peak gust wind speed exceeding 110 mph; c) fire; d) failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition; e) faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work; f) vapor condensation on bottom of roofing; and g) activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.

3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

IN WITNESS THEREOF, this instrument has been duly executed this ___________ day of ___________________ ,

Authorized Signature: ______________________

07 54 00 - 13
THERMOPLASTIC MEMBRANE ROOFING
SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes shop or field-formed and factory manufactured sheet metal flashing and trim and accessories.

B. Products Specified in This Section for Installation Under Other Sections:
   1. Furnish sheet metal items interfacing with membrane roofing for installation under Div. 07 Section "THERMOPLASTIC MEMBRANE ROOFING."

C. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 02-49 Sections specifying sheet metal flashing and trim by referencing this Section.
   4. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood nailers, curbs, and blocking.
   5. Div. 07 Section "JOINT SEALANTS" for field-applied sealants.

1.02 REFERENCES

A. Definitions:
   1. Definitions in the following apply to work of this Section:
      b. ANSI/SPRI GT-1.
   2. Manufactured: Products manufactured by a national or regional firm/vendor specializing in the fabrication of stock, semi-custom, and custom sheet metal flashing and trim. Where manufactured products are specified shop- or field formed products are not acceptable.
   3. Formed: Products shop- or field formed and fabricated by a local sheet metal shop specializing in the custom fabrication of sheet metal flashing and trim. Where shop- or field formed products are specified manufactured products may be substituted.

B. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. National Roofing Contractors Association (NRCA):
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Architectural Sheet Metal Manual. Comply with recommendations that apply to design, dimensions, metal, and other characteristics of item indicated. Refer discrepancies between Drawings and SMACNA recommendations to Architect for resolution.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Roofing: Coordinate installation of sheet metal flashing and trim with installation of adjoining roofing and wall materials to provide watertight, secure, and noncorrosive installation.
2. Walls: Coordinate installation of sheet metal flashing and trim with installation of wall-opening components such as windows, doors, and louvers to intercept and exclude penetrating moisture.

3. Penetrations: Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

2. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.

3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.

4. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.

5. Review observation and repair procedures after sheet metal flashing installation.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each product and accessory.

B. Shop Drawings: Distinguish between shop- or field-formed and factory manufactured items. Distinguish between shop- and field-assembled work. Shop Drawings for manufactured items shall be prepared by qualified design professional per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."

1. Include plans, elevations, sections, and attachment details.

2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details.

3. Include identification of material, thickness, weight, and finish for each item and location in Project.

4. Include details for forming, including profiles, shapes, seams, and dimensions.

5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

6. Include details of termination points and assemblies.

7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.

8. Include details of roof-penetration flashing.

9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.

10. Include details of special conditions.

11. Include details of connections to adjoining work.

12. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.

C. Samples: For verification.

1. Sample Size:
   a. Finish Samples: 6 inches square for sheet materials in each color and finish of exposed metals.

2. Include samples of each type fastener, cleat, clip, closure, and other attachments.
1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product Certificates: For each type of coping and roof-edge sheet metal that is SPRI ES-1 tested and FM Approvals approved.

B. Delegated-design submittal per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."
   Include design data for copings and roof edge securement metal for which design is assigned to Contractor.

C. Test and Evaluation Reports: As follows:
   1. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.

D. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: Listed in FM Approvals' "RoofNav" as able to fabricate required details as FM tested and approved for copings, gravel stop/fascia, gravel stops, and cap fascia.
   2. Fabricator Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An NRCA authorized fabricator, certified as able to fabricate required details as SPRI ES-1 tested and approved for copings, gravel stop/fascia, gravel stops, and cap fascia.
   3. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An employer of workers trained for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   4. Welder Qualifications: Procedures and personnel qualified by AWS within past 12 months for each type of joint required per AWS D9.1M/D9.1 and AWS B2.3/B2.3M.
   5. Design Professional Qualifications: Per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."

1.08 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS and as follows:
   1. Handle sheet metal flashing and trim in a manner to prevent bending, warping, twisting, and surface damage.
2. Store sheet metal materials to prevent contact with other materials that might cause staining, denting, or surface damage. Store sheet metal materials away from uncured concrete and masonry.
3. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for period of installation.

1.09 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".
B. Warranty for Applied Finishes: As specified in Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.
B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 DESCRIPTION

A. Product Options: Information on Drawings and in Specifications establishes requirements for sheet metal assemblies’ aesthetic effects and performance characteristics.
   1. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect’s approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
   2. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

2.03 PERFORMANCE REQUIREMENTS / DESIGN CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design manufactured copings and roof edge securement metal using performance requirements and design criteria specified herein.
B. Comply with applicable provisions of referenced standards and the following:
   1. Flashing and sheet metal assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather and shall remain watertight without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
C. FM Approvals Listing: Manufacture and install copings and roof edge securement metal that are listed in FM Approvals’ "RoofNav" and approved for windstorm classification Class 1-90. Identify materials with name of fabricator and design approval by FM Approvals.
D.  SPRI Wind Design Standard: Manufacture and install copings and roof edge securement metal tested as follows that are capable of resisting design wind loads. Identify materials with name of fabricator and ITS product certification mark labels.
   1. Manufacture and install copings that have been tested for wind resistance per Test Methods RE-3 of ANSI/SPRI/FM 4435/ES-1.
   2. Manufacture and install roof edge securement metal that has been tested for wind resistance per Test Methods RE-2 of ANSI/SPRI/FM 4435/ES-1.
   3. Manufacture and install gutters that have been tested per ANSI/SPRI/GT-1.

E. Structural Performance Requirements: Manufacture and install flashing and sheet metal, including anchorages, capable of withstanding, without failure, the effects of the following loads and stresses, within limits and under conditions indicated, determined per applicable code requirements and as follows:
   1. Design Wind Loads: As indicated on Drawings.

F. Thermal Performance Requirements: Provide flashing and sheet metal that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.04 MANUFACTURED COPING

A. Manufactured Coping: Manufacture coping cap with one-way sloped top and with vertical face and back leg fascia terminating in hemmed drip edges. Fabricate for attachment with face leg hooked to continuous cleat and with back leg attached with exposed fasteners. Drill elongated holes at 24 inch centers for fasteners on back leg.
   1. Profile: As indicated on Drawings.
   2. Miters: Factory manufacture matching, watertight mitered corners, width transitions, vertical transitions, tees, zees, and end caps by the following method.
      a. Joints for Metallic-Coated Steel Sheet: Mechanically clinched and sealed.
      b. Joints for Aluminum: Weld 0.040 inch and thicker. Mechanically clinched and sealed thinner metal.
   3. Section Length: 8 feet minimum; 10 feet maximum.
   4. Joint Style: Butt with expansion space with concealed, matching backup plate (SMACNA Fig. 3-3, Style 18) of material and thickness matching coping cap.
   5. Front Face Cleat: Continuous; galvanized- or stainless steel sheet of same gage as coping cap, formed to engage hemmed drip edge of face leg.

2.05 FORMED GRAVEL STOP/FASCIA

A. Formed Gravel Stop/Fascia (no gutter): Form with top angled back to a horizontal roof flange with vertical face leg fascia terminating in hemmed drip edge.
   2. Profile: As indicated on Drawings.
   3. Miters: Shop fabricate matching, watertight mitered corners, transitions, and terminations by the following method.
      a. Joints: Mechanically clinched and sealed.
4. Section Length: 8 feet minimum; 10 feet maximum.
5. Joint Style: Butt with expansion space and 12 inch wide, concealed, matching backup plate (SMACNA Fig. 3-3, Style 18) of material and thickness matching gravel stop/fascia.
6. Cleats: Continuous galvanized- or stainless steel sheet of same gage as gravel stop/fascia, formed to engage hemmed drip edge of face leg.

B. Formed Gravel Stop/Fascia (with gutter): Form with top angled back to a horizontal roof flange with vertical face leg fascia terminating in hemmed drip edge overlapping back edge of gutter.
2. Profile: As indicated on Drawings.
3. Miters: Shop fabricate matching, watertight mitered corners, transitions, and terminations by the following method.
   a. Joints : Mechanically clinched and sealed.
4. Section Length: 8 feet minimum; 10 feet maximum.
5. Joint Style: Butt with expansion space and 12 inch wide, concealed, matching backup plate (SMACNA Fig. 3-3, Style 18) of material and thickness matching gravel stop/fascia.
6. Cleats: Continuous; 0.0336 inch galvanized-steel or 0.0312 inch stainless-steel sheet to engage hemmed drip edge of face leg.
7. Fabricate with matching scuppers through gravel stop per SMACNA Fig. 1-11 spaced 10 feet apart, to dimensions required with 4 inch wide flanges and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.

2.06 ROOF DRAINAGE SYSTEM FABRICATIONS

A. Formed Hanging Gutters: Form to profile indicated, complete with rectangular gutter bead with reinforcing bars, outlet tubes, end pieces, and other accessories as required.
1. Profile: Per SMACNA Fig. 1-2, Style A.
2. Miters: Shop fabricate matching, watertight mitered corners, transitions, and end caps by the following method.
   a. Joints for Metallic-Coated Steel Sheet: Mechanically clinched and sealed.
   b. Joints for Aluminum: Weld 0.040 inch and thicker. Mechanically clinched and sealed thinner metal.
3. Section Length: 8 feet minimum; 50 feet maximum from downspout to expansion joint or end.
4. Expansion Joint Style: Butt with expansion space and 6 inch wide, exposed, matching cover plate (SMACNA Fig. 1-7) of material and thickness matching gutter.
5. Cleats: Continuous; 0.0336 inch galvanized-steel or 0.0312 inch stainless-steel sheet with hooked front edge to overlap and engage hook in top of back edge of gutter.
6. Brackets and Straps: Matching flat-stock fabricated from same material as gutters; 1/8 by 1 inch size, but in no case shall bracket thickness be less than twice that of gutter.
7. Spacers: Flat-stock fabricated from same material as gutters; 1/16 by 1 inch size.

B. Formed or Manufactured Downspouts: Form or manufacture to dimensions indicated.
1. Style: Rectangular (SMACNA Fig. 1-32B or Fig. 1-31-1).
2. Miters: Shop fabricate matching, watertight mitered elbows and transitions by the following method.
   a. Joints for Metallic-Coated Steel Sheet: Mechanically clinched and sealed.
   b. Joints for Aluminum: Weld 0.040 inch and thicker. Mechanically clinched and sealed thinner metal.
3. Section Length: 8 feet minimum; 12 feet maximum.
4. Joint Style: Joggle lap with expansion space and with 1-1/2-inch extension (SMACNA Fig. 3-2, Style 13).
5. Hangers: U-shaped with concealed wall fasteners SMACNA Fig. 1-35A shop fabricated from same material as downspouts in 1/8 by 1 inch size.

C. Accessories: Fabricated from same metal as gutters.
   1. Outlet tubes to fit downspout size and shape (SMACNA Fig. 1-33A).
   2. Wire ball downspout strainers at each outlet tube (SMACNA Fig. 1-24D).

2.07 MANUFACTURED LOW SLOPE ROOF EDGE COUNTERFLASHING

A. Manufactured Roof Edge Counterflashing: Manufacture in two-pieces with reglet and removable spring counterflashing to protect top edge of roofing where turned up walls.
   1. Profile: As indicated on Drawings.
   2. Miters: Factory manufacture matching, watertight mitered corners, transitions, and terminations by the following method.
      a. Joints for Stainless Steel: Soldered, brazed, or welded.
   3. Section Length: 8 feet minimum; 10 feet maximum.
   4. Manufactured Reglets: Manufacture of type and profile to engage and securely hold removable counterflashing; with factory mitered corners.
      a. Masonry Type: For embedment in masonry mortar joint.
      b. Siding Type: For mounting behind siding.
      c. Surface-Mounted Type: With slotted holes for fastening to substrate and with channel for sealant at top edge.

2.08 FORMED LOW SLOPE ROOF FLASHING

A. Formed Roof Penetration Flashing:
   1. Pipes and Conduits:
      a. Where pipes and conduits extend vertically through curbed openings, form curb cover per SMACNA Fig. 8-8.
      b. Where pipes and conduits extending through curbed openings bend horizontally, form two-piece curb cover similar to SMACNA Fig. 8-9A.
   2. Steel Structural Members: Cut and form flashing to fit tight to steel member profile. Weld flashing to steel with continuous, watertight weld. Form removable roof edge counterflashing below per SMACNA Fig. 8-9A.
   3. Vent Stacks: Two-piece type similar to SMACNA Fig. 8-9B.
   4. Umbrella with Draw-Band: At round penetrations, including above pre-molded flexible cone flashing, form umbrella counterflashing with stainless steel draw band per SMACNA Fig. 8-9C.

B. Formed Equipment Support Flashing: Per SMACNA Fig. 4-17.
   1. Round Support Members: Treat as specified for umbrella with draw-band roof penetrations above per SMACNA Fig. 8-11A.
   2. Steel Shapes (angle, channel, wide-flange, etc.): Treat as specified for steel structural member roof penetrations above.
   3. Caps for Support Curbs: At field-constructed curbs, form cap cover on curb per SMACNA Fig. 8-11B.
   4. Pitch Pans: Form per SMACNA Fig. 8-11C.
      a. Bonnet: Form bonnets above pitch pans as specified for umbrella with draw-band or steel structural member roof penetrations above as appropriate to shape of penetrating item.

C. Form other flashing to shapes indicated on Drawings from material scheduled.
2.09 FORMED MASONRY WALL JOINT FLASHING

A. Section Length for Linear Flashing Members: 8 feet minimum; 10 feet maximum, unless otherwise indicated.

B. Formed Smooth Through-Wall Flashing: Form continuous flashings at lintels, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2 inch high, end dams.

C. Formed Drip Edges for Flexible Masonry Joint Flashing: Extend at least 3 inches into wall. At exterior face of wall, bend outer edge down 30 degrees and hem.

2.10 FORMED FRAMED WALL FLASHING

A. Section Length for Continuous Linear Flashing Members: 8 feet minimum; 10 feet maximum, unless otherwise indicated.

B. Formed Opening and Penetration Flashing: Form head, sill, and similar flashings to extend minimum 4 inches beyond wall openings. Form head and sill flashing with 2 inch high end dams sealed or soldered watertight.
   1. Door and Window Head Flashing: As indicated on Drawings. Form with back and end dams.
   2. Window Sill Flashing: As indicated on Drawings. Form with back and end dams.
   3. Pipe and Conduit Penetrations: Similar to SMACNA Fig. 8-4.
   4. Square or Rectangular Tube or Duct Penetrations: Similar to SMACNA Fig. 8-6.
   5. Flanged or Angle Steel Member Penetrations: Similar to SMACNA Fig. 8-7.

C. Form other flashing to shapes indicated on Drawings from material scheduled.

2.11 FORMED METAL PANEL WALL FLASHING

A. See Div, 07 Section “METAL WALL PANELS” for manufactured wall panels including flashing and trim.

2.12 MISCELLANEOUS FORMED SHEET METAL FABRICATIONS

A. Formed Backup Support: Provide bent metal angles and 'Z' shapes where required for flashing and sheet metal attachment as required to prevent unsupported metal flashing edges; minimum 0.0217 inch thickness or same metal being supported.

B. Form other flashing to shapes indicated on Drawings from material scheduled.

2.13 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead soft, fully annealed; with smooth, flat surface; finished per ASTM A480 as follows:
   1. No. 2D Mill Finish - Cold-rolled, dull finish.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) steel sheet with Class G90 coating designation or ASTM A 792/A 792M
aluminum-zinc alloy-coated (Galvalume®) steel sheet with Class AZ50 coating designation, Grade 40 with smooth, flat surface; finished as follows:

1. Superior-performance organic finish per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

D. Aluminum Sheet: ASTM B 209, alloy and temper as standard with manufacturer for finish and forming operations and performance required; with smooth, flat surface; finished as follows:

1. Superior-performance organic finish per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

2.14 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: ASTM D 1970/D 1970M; minimum 40 mils thick, consisting of rubberized asphalt laminated on one side to a slip-resistant polyethylene- or polypropylene-film reinforcement, and with release liner on adhesive side; specifically designed to withstand high metal temperatures beneath sheet metal. Provide primer per written recommendations of underlayment manufacturer.

1. Products:
   a. WIP 300HT by Carlisle Coatings & Waterproofing Inc.
   b. Grace Construction Products, a unit of W. R. Grace & Co.-Conn.; Grace Ice and Water Shield HT.
   d. Comparable products by other manufacturers will be considered.


3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.15 MISCELLANEOUS MATERIALS

A. General: Provide materials as required for complete flashing and sheet metal installation and as recommended by referenced standards and manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Designed to withstand design loads and recommended by fastener manufacturer for intended use.

1. Screws: Series 300 stainless steel with hex-washer head, self-drilling screws with metal-backed EPDM or PVC sealing washers under heads. Where exposed to view, provide plastic caps or factory-applied coating matching color of sheet metal.

2. Tinner's Rivets: Solid rivets with a flat head of same material as sheet metal to be fastened.

3. Blind Rivets: Closed-end, high-strength type of same material as sheet metal to be fastened. Where rivets of same material are not available, provide Series 300 stainless steel rivets.

C. Solder and Flux: Select according to AWS specifications, cited standard, and as recommended by solder manufacturer for metals to be joined. Use lead-free compositions.

1. For Zinc-Coated (Galvanized) Steel and Stainless Steel: ASTM B 32, Grade Sn96.

D. Brazing and Welding Rods and Bare Electrodes: Select according to AWS specifications and as recommended by rod manufacturer for metals to be joined.
E. Sealant Tape: Pressure-sensitive, permanently elastic, nonsag, nontoxic, nonstaining, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing; 3/8 to 1/2 inch wide by 1/8 inch thick.

F. Sealant: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: ASTM D 1187 cold-applied asphalt emulsion or ASTM D4479, Type I asphalt roof coating.

I. Splash Blocks: Precast concrete units; nominal 12 by 24 by 3 inch size shaped to channel water away from walls at downspout locations.

2.16 FABRICATION

A. Custom fabricate flashing and sheet metal, in shop to greatest extent possible, to comply with details shown and recommendations in cited sheet metal standards that apply to design, dimensions, geometry, and other characteristics of item required.
   1. Fabricate flashing and sheet metal in thickness or weight needed to comply with performance requirements, but not less than that scheduled or indicated for each application and metal.
   2. Obtain field measurements for accurate fit before shop fabrication.
   3. Form flashing and sheet metal to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   4. Conceal fasteners where possible.
   5. Do not use graphite pencils to mark metal surfaces.

B. Fabricate flashing and sheet metal that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8 inch offset of adjoining faces and of alignment of adjacent profiles.

C. Form metal flashing and trim for installation allowing for thermal expansion.

D. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured. Fabricate from same material as accessory being anchored, unless otherwise indicated.

E. Seams and Joints: Form flashing and sheet metal seams and joints per cited sheet metal standard to allow for proper installation, to accommodate thermal expansion, and to accommodate field jointing. Where moving joints are required, form metal to allow for proper installation and concealment of sealant.

F. Fixed Seams and Joints in Shop Fabricated Assemblies: Form seams and seal as follows, unless otherwise indicated:
   1. Metal Less Than 0.040 Inch Thick: Flat-lock seams (SMACNA Fig. 3-2, Style 2); treat as follows.
b. Other Metals: Tin edges to be seamed, form seams, and solder as specified in Fabrication Article in PART 2 PRODUCTS above. Neutralize flux after soldering. Touch up coating finish with matching air-dried coating.

2. Metal Greater Than or Equal to 0.040 Inch Thick: Butt seams with backup plates, fastened one side and sealed with butyl sealant (SMACNA Fig. 3-3, Style 19); concealed within joint.

G. Soldered, Brazed, and Welded (i.e. "Fused") Joints: Comply with AWS and cited standards and filler metal manufacturer's recommendations.

1. Unless otherwise specified, do not fuse prepainted metal sheet.

2. Pretin edges of sheets to be soldered to a width of 1-1/2 inches. Reduce width to minimize pretinned surface visibility in finished Work. Promptly remove acid flux residue from metal after tinning.


H. Sealed Joints: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

2.17 FINISHES, GENERAL

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

3.02 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.

2. Verify roof openings, curbs, penetrating pipes, sleeves, ducts, and vents through roof are solidly set, reglets are in place, and nailing strips are located.

3. Verify roofing termination and base flashings are in place, sealed, and secure.

4. Verify that substrates are sound, dry, smooth, clean, sloped for drainage, and securely anchored.

5. Verify that air- or water-resistant barriers have been installed over backing substrate to prevent air infiltration or water penetration.

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

3.03 INSTALLATION, GENERAL

A. General: Install sheet metal flashing and trim to comply with performance requirements, cited sheet metal standards, manufacturer's written installation instructions, and approved submittals to result in permanently watertight and weather resistant performance.

1. Install starter and edge strips, and cleats before starting sheet metal installation. Space cleats per cited sheet metal standards. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
2. Install surface-mounted reglets and seal top of reglets with sealant.
3. Install to fit substrates true to line, levels, and slopes indicated. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
4. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal expansion and structural movement. Install miscellaneous items as required to complete sheet metal flashing and trim system.
5. Install work with laps, joints, and seams that are permanently watertight and weather resistant. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
6. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
7. Torch cutting of sheet metal flashing and trim is not permitted.
8. Do not use graphite pencils to mark metal surfaces.
9. Remove temporary protective coverings and strippable films as installation of sheet metal flashing and trim progresses unless otherwise indicated in manufacturer’s written installation instructions.

B. Metal Protection: Protect sheet metal against galvanic action or corrosion as follows:
1. Where dissimilar metals contact each other and where sheet metal contacts ferrous metal or other corrosive substrates, coat contact surfaces of sheet metal with bituminous coating.
2. Where sheet metal is installed directly on wood substrates or cementitious materials, install sheet metal over self-adhering sheet underlayment and slip sheet.
   a. Install self-adhering sheet underlayment, wrinkle free. Comply with priming requirements and temperature restrictions of underlayment manufacturer for installation. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Do not leave underlayment exposed to the elements for more than 14 days.
   b. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim. Secure in place with tape or adhesive.

C. Fasteners: Use fastener sizes that penetrate substrate as recommended by fastener manufacturer to achieve maximum pull-out resistance, but in no case less than 1-1/4 inches for nails and 3/4 inch for wood screws in wood blocking or sheathing.
1. Rivet joints where indicated and where necessary for strength.
2. Conceal fasteners where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a secure, watertight installation.

3.04 SEAMS AND JOINTS

A. Expansion Provisions: Form and install metal flashing and trim with expansion joints to accommodate thermal expansion and structural movement.
1. Space movement joints per cited standards with no joints within 24 inches of corner or intersection.
2. Size joint expansion space to allow for movement potential based on metal material coefficient of expansion and accounting for ambient temperature at time of installation but never less than 1 inch size. Allow for compression and elongation limitations of sealants to be applied.
   a. When ambient temperature at time of installation is between 50 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher or lower temperatures.

B. Moving Seams and Joints: As follows, unless otherwise indicated:
1. Metal Less Than 0.040 Inch Thick: Interlocking hook seam (SMACNA Fig. 3-2, Style 1), of depth to accommodate anticipated movement but not less than one inch deep, filled with butyl sealant concealed within joint.

2. Metal Greater Than or Equal to 0.040 Inch Thick: Butt seams with expansion space with backup plates fastened to substrate (SMACNA Fig. 3-3, Style 18) with no fasteners exposed through covers; seal with butyl sealant concealed within joint.

3. Use lapped expansion joints only where specified or indicated on Drawings.

C. Fixed Seams and Joints: Form seams and seal as follows, unless otherwise indicated:

1. Metal Less Than 0.040 Inch Thick: Flat-lock seams (SMACNA Fig. 3-2, Style 2); treat as follows.
   b. Other Metals: Remove paint, lacquer and other coatings. Tin edges to be seamed, form seams, and solder as specified in Fabrication Article in PART 2 PRODUCTS above. Neutralize flux after soldering. Touch up coating finish with matching air-dried coating.

2. Metal Greater Than or Equal to 0.040 Inch Thick: Butt seams with backup plates, fastened one side and sealed with butyl sealant (SMACNA Fig. 3-3, Style 19); concealed within joint.

D. Seal moving and fixed joints as required for watertight construction, unless otherwise indicated. Conceal sealant within joints where possible. Comply with requirements in Div. 07 Section "JOINT SEALANTS."

E. Field Soldered Joints: Comply with AWS and cited standards and filler metal manufacturer's recommendations.

1. Do not use torches for soldering.
2. Do not solder prepainted metal sheet.
3. Pretin edges of sheets to be soldered to a width of 1-1/2 inches. Reduce width to minimize pretinned surface visibility in finished Work. Promptly remove acid flux residue from metal after tinning.

3.05 COPING INSTALLATION

A. Anchor copings to resist uplift and outward forces to comply with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals’ listing for required windstorm classification, performance requirements, manufacturer's written installation instructions, and cited sheet metal standard.

1. Interlock face leg drip edge into continuous cleat anchored to substrate at manufacturer's recommended spacing. Anchor back leg of coping with screw fasteners and elastomeric washers at manufacturer's recommended spacing.

3.06 GRAVEL STOP/FASCIA INSTALLATION

A. Anchor gravel stop/fascia to resist uplift and outward forces to comply with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals’ listing for required windstorm classification, performance requirements, manufacturer's written installation instructions, and cited sheet metal standard.
3.07 ROOF DRAINAGE SYSTEM INSTALLATION

A. Install sheet metal roof-drainage items to produce complete roof-drainage system per cited sheet metal standard, unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters: Join sections with joints sealed with sealant. Firmly anchor gutters in position allowing for thermal expansion and sloped to downspouts. Install end closures sealed watertight.
   1. Fasten gutter spacers to front and back of gutter.
   2. Anchor and loosely lock back edge of gutter to continuous cleat.
   3. Support gutters with gutter brackets spaced not more than 36 inches apart, unless otherwise indicated, and loosely lock to front gutter bead.
   4. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart.

C. Downspouts: Join telescoping joint sections with upper sections inserted into lower sections allowing for thermal expansion.
   1. Install hangers with appropriate fasteners and wall anchors designed to hold downspouts securely to walls at top and bottom and at approximately 60 inches o.c.
   2. Provide elbows at base of downspout to direct water away from building.

D. Accessories:
   1. Install valley corner baffles at internal corners of gutters.
   2. Install outlet tubes in gutters at each downspout. Rivet and seal in place.
   3. Install wire ball downspout strainers at each downspout outlet tube.

E. Splash Blocks: Install where downspouts discharge on low-sloped roofs and at grade. Set on scrap layer of roofing membrane compatible with roofing membrane. Set loose on paving at grade.

3.08 LOW SLOPE ROOF FLASHING INSTALLATION

A. Roof Edge Counterflashing: Coordinate counterflashing installation with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of anchor and washer at 36-inch centers unless otherwise indicated.

B. Roof Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and items penetrating roof.
   1. Pipes and Conduits Through Curbed Openings: Set covers on curbs in bed of butyl sealant. Seal openings around pipes and conduits with elastomeric sealant.
   2. Vent Stacks: Extend counterflashing 4 inches over base flashing and bend into vent pipe.
   3. Round Penetrations: Install counterflashing umbrella with close-fitting collar with top edge flared for sealant, extending minimum of 4 inches over base flashing. Install draw band and tighten. Seal with elastomeric sealant.

C. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Seal flashing to equipment support member with elastomeric sealant.
   1. Caps for Support Curbs: Set caps on curbs in bed of butyl sealant. Seal openings around pipes and conduits with elastomeric sealant.

D. Area Separation/Relief Joint: Set in manner similar to coping caps.
3.09 MASONRY WALL JOINT FLASHING INSTALLATION

A. Sheet metal flashing and trim installation is specified in Div. 04 Section "UNIT MASONRY."

3.10 FRAMED WALL FLASHING INSTALLATION

A. Opening Flashings:
   1. Set sill flashing in a bed of butyl sealant.
      a. At brick ledges, extend flashing onto brick 1-1/2 inches beyond window frame and terminate with sealant under a hemmed edge.
      b. Extend flashing slightly beyond wall surface below and turn down flashing terminating in a hemmed drip edge.
   2. Set jamb flashings and mullion covers to overlap sill flashings.
   3. Set head flashings to overlap jamb flashings and mullion covers and direct water beyond door or window frame.

B. Penetration Flashing: Coordinate installation of wall-penetration flashing with installation of items penetrating walls.

3.11 METAL PANEL WALL FLASHING

A. Sheet metal flashing and trim installation is specified in Div. 07 "METAL WALL PANEL" Sections.

3.12 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.13 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Finish Touchup:
   1. Immediately after installation, repairing damage to paint finishes per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

C. Replace sheet metal flashing and trim that has been damaged or that has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.14 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   1. On completion of sheet metal flashing and trim installation, clean finished surfaces as recommended by referenced standards and sheet metal flashing and trim manufacturer.
   2. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
   3. Clean and neutralize flux materials. Clean off excess solder.
   4. Clean off excess sealants.
   5. Maintain sheet metal flashing and trim in clean condition during construction.
3.15 PROTECTION

A. Per Div. 01 Section "EXECUTION."

3.16 ATTACHMENTS

A. Schedule: Refer to separate “SHEET METAL FLASHING AND TRIM SCHEDULE” for areas of application and sheet metal material, thickness, and finish.

END OF SECTION 07 60 00
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<th>Sheet Metal Item</th>
<th>Visible / Concealed</th>
<th>Metal Material</th>
<th>Minimum Thickness ††</th>
<th>Finish ‡</th>
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### LOW-SLOPE ROOF FLASHING

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### STEEP-SLOPE [SHINGLE] [SHAKE] [SLATE] [TILE] ROOF FLASHING

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### MASONRY WALL JOINT FLASHING

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### FRAMED WALL FLASHING

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</table>

### GENERAL NOTES

† Visible is defined as "able to be seen from normal public areas in the finished structure, excluding lower level roofs visible from higher floors." Provide factory finished material in visible locations, unless otherwise indicated.

‡ Thickness shown are minimums. Increase thickness as required to comply with FM approvals listing and SMACNA recommendations and to meet performance requirements. Flashing thickness measurements are indicated in decimal inches, unless otherwise indicated.

‡ Refer to Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL" for paint finishes and colors.
SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following products for installation under Div. 07 Section "THERMOPLASTIC MEMBRANE ROOFING":
   1. Factory manufactured roof curbs and equipment support rails and pedestals.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Section "FLASHING AND SHEET METAL" for shop- and field-formed metal flashing.
   4. Facility Services Subgroup Sections for roof-mounted equipment.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Coordinate installation of roof accessories with installation of adjoining roofing materials to provide watertight, secure, and noncorrosive installation.
   2. Coordinate dimensions of roof accessories with roof opening sizes and rough-in information and Shop Drawings of equipment to be supported.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include standard construction details, profiles, material descriptions, dimensions of individual components, and finishes.

B. Shop Drawings: Include dimensioned plans, elevations, and section details of each type roof accessory showing means of attachment to other work. Indicate load capacity and special conditions. Distinguish between factory- and field-assembled work.

C. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show size and location of roof accessories specified in this Section and relationship to other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit with required clearances.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE / DESIGN CRITERIA

A. Structural Performance Requirements: Provide roof accessories capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings without failure.

B. Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement.

2.03 MANUFACTURED CURBS


1. Manufacturers:
   a. AES Industries, Inc.
   b. Curbs Plus, Inc.
   c. Greenheck Fan Corporation.
   d. Hart & Cooley, Inc.
   e. Pate Company (The).
   f. Comparable products by other manufacturers will be considered.

2. Sheet Metal: ASTM A 653/A 653M zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) steel sheet with Class G90 coating designation, or ASTM A 792/A 792M aluminum-zinc alloy-coated (Galvalume®) steel sheet with Class AZ50 coating designation, Grade 40; minimum 0.0516 inch thick or as required to support superimposed loads.


4. Fabricate to height indicated, but in no case less than 8 inches above finished roof surface.

5. Manufacture deck flanges suitable for installation on wood nailers around perimeter of deck opening.

B. Curbs at Roof Openings: One-piece continuous, insulated double-walled curb/liner with integral counterflashing to receive roof flashings.

1. Taper perimeter curb height to accommodate roof slopes so top surface of curb is level.

2. Factory insulate inside curbs with 1-1/2-inch thick board insulation as standard with manufacturer.

3. Factory install continuous, preservative treated wood nailers, 3-1/2 inches wide, around top of curb perimeter.

C. Equipment Support Rails: Two-sided, linear curbs of lengths as required to support equipment indicated.

1. Manufacture in heights as required to accommodate roof slopes so top surface of rails supporting a common item of equipment are level.

2. Factory install continuous, preservative treated wood nailers, 3-1/2 inches wide, along tops of equipment support rail and pedestals.
**D. Pipe, Duct, and Conduit Mounting Pedestals:**
1. **Non-Penetrating Type:** Steel pedestals with square, round, or rectangular bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly.
   a. **Bases:** High density polypropylene of sizes as required to distribute load sufficiently to prevent indentation of roofing assembly.
   b. **Height:** Provide minimum clearance of 6 inches under supported items to top of roofing.

2.04 **UNDERLAYER MATERIALS**

A. **Self-Adhering, High-Temperature Sheet:** ASTM D 1990/D 1990M; minimum 40 mils thick, consisting of rubberized asphalt laminated on one side to a slip-resistant polyethylene- or polypropylene-film reinforcement, and with release liner on adhesive side; specifically designed to withstand high metal temperatures beneath sheet metal. Provide primer per written recommendations of underlayment manufacturer.
1. **Products:**
   a. WIP 300HT by Carlisle Coatings & Waterproofing Inc.
   b. Grace Construction Products, a unit of W. R. Grace & Co.-Conn.; Grace Ice and Water Shield HT.
2. **Thermal Stability:** ASTM D 1970; stable after testing at 240 deg F or higher.
3. **Low-Temperature Flexibility:** ASTM D 1970; passes after testing at minus 20 deg F or lower.

B. **Slip Sheet:** Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.05 **MISCELLANEOUS MATERIALS**

A. **Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.**

B. **Steel Reinforcement Shapes:** ASTM A 36/A 36M, hot-dip galvanized according to Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL." unless otherwise indicated.

C. **Glass-Fiber Board Insulation:** ASTM C 726, thickness as indicated.

D. **Wood Blocking:** Softwood lumber per Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY", pressure treated, not less than 1-1/2 inches thick.

E. **Bituminous Coating:** ASTM D 1187 cold-applied asphalt emulsion or ASTM D4479, Type I asphalt roof coating.

F. **Fasteners:** Suitable for application and metals being fastened as recommended by curb manufacturer, of metal and finish to match metal being fastened. Provide nonremovable fastener heads at fasteners accessible from exterior.

G. **Sealant:** Compatible with adjacent materials and complying with requirements in Div. 07 Section “JOINT SEALANTS.” Provide butyl type where concealed and elastomeric type where exposed.
3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
   As follows:
   1. Examine substrates, areas, and conditions, with Installer present, to verify actual
      locations, dimensions, and other conditions affecting performance of the Work.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely
      anchored.
   3. Verify dimensions of roof openings for roof accessories.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. At insulated membrane roofing, install solid wood blocking, nominal 6 inch wide by depth of roof
   insulation to support roof accessories.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved
   submittals.
   1. Install roof accessories so top surface is level.
   2. Install equipment support rails so top surface of rails supporting a common item of
      equipment are level.
   3. Anchor securely in place to resisting indicated loads.

B. Metal Protection: Protect sheet metal against galvanic action or corrosion as follows:
   1. Where dissimilar metals contact each other and where sheet metal contacts ferrous
      metal or other corrosive substrates, coat contact surfaces of sheet metal with bituminous
      coating.
   2. Where sheet metal is installed directly on wood substrates or cementitious materials,
      install sheet metal over self-adhering sheet underlayment and slip sheet.

C. Seal joints watertight with sealant in locations required by manufactured curb manufacturer.

3.03 ADJUSTING

A. Per Div. 01 Section "EXECUTION."

B. Galvanized Surfaces: Immediately after erection, clean bolted connections, and abraded areas
   and repair galvanized surfaces per Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS
   FOR METAL."

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES."
SECTION 07 84 00 - FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes firestopping materials and systems installed in cavities, around penetrations, and openings in floors, walls, partitions, and other building components to prevent spread of fire and smoke.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 REFERENCES

A. Definitions:
   1. Terminology: Definitions in the applicable Building and Fire Codes and the following apply to work of this Section:

B. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
      a. ASTM E2174: Standard Practice for On-Site Inspection of Installed Fire Stops.
   3. International Firestop Council (IFC):
   4. Intertek Group PLC (ITS):
      a. ITS (DIR) - Directory of Listed Products.
   5. Underwriters Laboratories, Inc. (UL):
      a. UL (DIR) - Online Certifications Directory.
      b. UL (FRD) - Fire Resistance Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct per Div. 01 Section "PROJECT MEETINGS" prior to commencing work of this Section.
   1. Either at the Preconstruction meeting or at preinstallation meetings with the trade or trades installing firestopping, review required submittals, details, variances, and discuss and agree on the inspection process per IFC Inspection Guidelines for Penetration Firestop Systems and Fire Resistive Joint Systems in Fire Resistance Rated Construction.
B. Sequencing and Scheduling:
   1. Penetrations:
      a. Coordinate construction of openings and penetrating items to ensure that firestopping is installed according to specified requirements.
      b. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate firestopping.
   2. Joints:
      a. Coordinate construction of joints to ensure that fire-resistant joint systems are installed according to specified requirements.
      b. Coordinate sizing of joints to accommodate fire-resistant joint systems.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings prepared by approved by firestopping manufacturer’s fire-protection engineer.
   1. Submit copies of laboratory illustrations with description of system as tested.
   2. Where Project conditions require modification to a qualified illustration for a particular firestopping condition, or where there is no specific third party tested and classified firestop system available for a particular firestop condition, submit illustration, with modifications marked by firestop system manufacturer’s fire-protection engineer, as an Engineering Judgment (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA).

C. Product Schedule: For each firestopping system proposed for use, submit system classification mark or design listing, including location and illustrations from a qualified testing and inspection agency applicable to each specific firestop condition.
   1. Use format on attached “Firestopping Schedule” for format and information required for schedule submittal.

1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Submit manufacturer’s certification that firestop materials furnished for Project are asbestos free and meet or exceed specified requirements.
   2. For intumescent firestop materials used in through penetration systems, provide certification of compliance with UL 1479.
   3. Submit manufacturer’s certification that products supplied comply with local regulations controlling use of volatile organic compounds (VOC’s) and are nontoxic to building occupants.
   4. Submit installer’s certificate indicating firestopping has been installed in compliance with requirements and manufacturer’s written recommendations.
   5. Submit inspection certificates required by authorities having jurisdiction.

B. Test and Evaluation Reports: As follows:
   1. Product test reports for firestopping based on evaluation of comprehensive tests performed by a qualified testing agency.

C. Qualification Statements for manufacturer and installer.
1.06 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: FCIA manufacturer member company in good standing with minimum 3 years experience, and able to show evidence of at least 10 projects where similar products have been installed and accepted.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
   3. Firestop System Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" Additionally, inspector shall have passed UL Firestop Examination or FM Firestop Examination or IFC Firestop Special Inspector Examination.
   4. Design Professional (Manufacturer's Fire-Protection Engineer) Qualifications: Per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."

B. Field Constructed Mockups: Prior to installing firestopping, install mockups for each different firestop system indicated to verify selections made and to demonstrate qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final installations.
   1. Locate mockups on site in locations indicated or, if not indicated, as directed by Architect. Include mockup for each type of system and identify benchmark installations as such.
   2. Notify Architect in advance of the dates and times when mockups will be installed.
   3. Owner's qualified special inspector will perform destructive testing on mockups to verify that mockups have been installed in compliance with requirements of tested and listed firestop system.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.08 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Do not install firestopping when substrates are wet due to precipitation, frost, condensation, or other causes.
   2. Install firestopping only when temperature and conditions comply with firestopping manufacturer's recommendations.
   3. Maintain ambient temperatures and humidity within range recommended by manufacturer in spaces to receive firestopping during the following time periods:
      a. 48 hours before installation.
      b. During installation.
      c. 72 hours after installation.

B. Provide ventilation to properly cure firestopping per manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 MANUFACTURERS

A. Manufacturers:
   1. 3M Fire Protection Products.
   3. Hilti, Inc.
   5. RectorSeal Corporation.
   6. Specified Technologies Inc.
   7. Comparable products by other manufacturers will be considered.

B. Project Source Limitations: Obtain firestop system products for each kind of penetration and construction condition indicated through one source from a single manufacturer for entire Project, unless otherwise acceptable to Architect.
   1. Obtain secondary and incidental components from same manufacturer as firestop system or manufacturer approved by firestop system manufacturer.
   2. Do not intermix materials of different manufacturer in the same firestop system unless allowed by the tested and listed system.
   3. Provide tested and listed firestop systems conforming to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance when possible.
      a. When tested and listed firestop systems do not exist for an encountered condition, provide systems with an Engineering Judgment (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA) acceptable to authorities having jurisdiction.

2.03 DESCRIPTION

A. Provide firestopping in locations indicated including, but not limited to, the following:
   1. Penetration firestops in fire-resistance-rated walls and horizontal assemblies and smoke barriers including both empty openings and openings that contain penetrations.
   2. Fire-resistant joint systems in or between adjacent assemblies.
   3. Perimeter fire barrier systems along the perimeter of a fire-resistance-rated floor and a non-rated exterior curtain wall.

2.04 PERFORMANCE CRITERIA

A. Fire-Test-Response Characteristics: Provide firestop systems tested per standards referenced by a qualified testing agency acceptable to authorities having jurisdiction and bearing classification markings of qualified testing agency. Listing by the following in their certification directories will be considered evidence of successful testing.
   1. FM (AG) - FM Approval Guide.
   2. ITS (DIR) - Directory of Listed Products.
   3. UL (DIR) - Online Certifications Directory.
   4. UL (FRD) - Fire Resistance Directory.
   5. Comparable systems tested by other qualified testing agencies will be considered.

B. Firestopping shall:
   1. Resist passage of fire, smoke, and hot gases and maintain the original fire-resistance rating of construction penetrated.
   2. Be compatible with one another, with the substrates forming openings, and with penetrating items if any.
   3. Accommodate building movements without impairing their ability to resist the passage of fire, smoke, and hot gases.
4. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or be protected by a permanent barrier to prevent loading or traffic in the firestopped area.

C. Damage Resistance: For firestopping exposed to traffic, moisture, and physical damage, provide firestop systems appropriate for the condition.

D. Mold Resistance: Provide firestopping materials with mold and mildew resistance rating of 0 per ASTM G21.

2.05 PENETRATION FIRESTOPPING ASSEMBLY REQUIREMENTS

A. General: Use any ASTM E814 or UL 1479 tested system complying with the following:

B. Penetrations in Fire-Resistance-Rated Walls Including Fire Walls, Fire-Barrier Walls, Shaft Enclosure Walls, Smoke-Barrier Walls, Smoke Partitions, and Fire Partitions:
   1. F-Rating: Not less than the fire-resistance rating of the penetrated assembly.
   2. L-Rating at Ambient: Less than 5.0 cfm/sq. ft.
   3. L-Rating at 400 Deg F: Less than 5.0 cfm/sq. ft.

C. Penetrations in Fire-Resistance-Rated Horizontal Assemblies Including Floors, Floor/Ceiling Assemblies, and Ceiling Membranes of Roof/Ceiling Assemblies:
   1. F-Rating: Not less than the fire-resistance rating of the penetrated assembly.
   2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of the penetrated assembly. Floor penetrations located within the cavity of a wall or shaft enclosure do not need to be T-Rated.
   3. L-Rating at Ambient: Less than 5.0 cfm/sq. ft.
   4. L-Rating at 400 Deg F: Less than 5.0 cfm/sq. ft.
   5. W-Rating: No water leakage at completion of water leakage testing.

2.06 JOINT FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Floor-to-Floor (FF), Wall-to-Wall (WW), and Floor-to-Wall Joints (FW), Except Perimeter Joints, Where Both Are Fire-Rated: Use any ASTM E1966 or UL 2079 tested system complying with the following:
   1. F-Rating: Not less than the fire-resistance rating of the assembly in which the joint occurs.
   2. L-Rating at Ambient: Less than 5.0 cfm/sq. ft.
   3. L-Rating at 400 Deg F: Less than 5.0 cfm/sq. ft.
   4. W-Rating: No water leakage at completion of water leakage testing for FF and FW joints.
   5. Movement: In addition, provide systems that have been tested to show movement capability as indicated.

B. Head-of-Wall (HW) Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any ASTM E2837 tested system complying with the following:
   1. F-Rating: Not less than the fire-resistance rating of the floor or wall, whichever is greater.
   2. Movement: In addition, provide systems that have been tested to show movement capability as indicated.

C. Perimeter Fire Containment Firestopping (CW): Use any ASTM E2307 tested system complying with the following:
   1. F-Rating: Not less than the fire-resistance rating of the floor assembly.
   2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of the penetrated assembly. Floor penetrations located within the cavity of a wall or shaft enclosure do not need to be T-Rated.
   3. L-Rating at Ambient: Less than 5.0 cfm/sq. ft.
4. L-Rating at 400 Deg F: Less than 5.0 cfm/sq. ft.

5. Movement: In addition, provide systems that have been tested to show movement capability as indicated.


2.07 MATERIALS

A. Firestop Materials: Use any material meeting requirements.

B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

C. Re-Enterable Firestopping Devices: Pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices shall be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants; while maintaining "L" rating of <10 cfm/sf measured at ambient temperature and 400 degrees F at 0 percent to 100 percent visual fill.

D. Re-Sealable Firestopping Products: Pre-manufactured modular products, containing self-sealing intumescent inserts. Firestopping products shall allow for cable moves, additions or changes. Devices shall be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants.

2.08 MIXING

A. For products requiring mixing before application, comply with firestopping manufacturer's written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates and conditions, with Installer present, for compliance with requirements for opening or joint configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Notify the responsible party or parties of any unsatisfactory conditions.
   1. Verify that installation of all required penetrating items are complete prior to installation of firestopping.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Surface Cleaning: Clean substrate surfaces of openings and joints immediately before installing firestopping per manufacturer's written instructions and as follows:
   1. Remove dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond.
   2. Remove loose particles and incompatible materials that could adversely affect bond.

D. Priming: Prime substrates per manufacturer's written instructions. Confine primers to areas of bond, avoiding spillage and migration onto exposed surfaces.

07 84 00 - 6
FIRESTOPPING
3.02 INSTALLATION

A. Install firestopping materials in manner described in fire test report and per manufacturer's instructions, completely closing openings and joints regardless of geometric configuration.

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.

C. Install fill materials by proven techniques to produce the following results:
   1. Apply fill materials so they contact and adhere to substrates formed by openings and penetrating items and joints.
   2. Tool sealant-type materials immediately after their application and prior to the time skinning begins to eliminate air pockets and ensure contact and adhesion with sides of joint.
   3. Finish fill materials that will remain exposed after completing the Work to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:
   1. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
   2. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
   3. Construction joints in floors and fire rated walls and partitions.
   4. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of floor and roof decks.
   5. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.
   6. Other locations where required to maintain fire resistance rating of the construction.

E. Insulated Pipes and Ducts: Cut and remove thermal insulation where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

F. Fire Dampers: Install and firestop fire dampers in accordance with Div. 23 Sections. Firestop installed with fire damper shall be tested and approved for use in fire damper system.

G. Data and Communication Cabling: Cabling for data and communication applications shall be sealed with re-enterable firestopping products and devices.

3.03 IDENTIFICATION

A. Label or mark firestopping with preprinted mechanically attached metal labels or permanently bonding, self-adhering plastic labels so labels will be visible to anyone seeking to remove or penetrate firestop system.
   1. For penetration type firestop systems, locate adjacent to and within 6 inches of any edge of the firestop system or assembly.
   2. For head-of-wall, expansion joint, and floor/ exterior wall slab edge type firestop systems, locate adjacent to and within 6 inches of the firestop system or assembly and spaced not more than 50 feet o.c.
3. Labels may be omitted where they would be visible in a finished area with written authorization of authorities having jurisdiction.

B. Labels for fire resistance rated systems shall contain the following information:
   1. Design number or designation of applicable testing agency.
   2. The words "Installed by {contractor's name, address, and phone number}"
   3. The words "Do Not Disturb - Fire Resistance Rated Firestop System".
   4. The words "Notify Building Management of Any Damage".
   5. Date of installation.

C. Labels for equivalent fire resistance rated systems shall contain the following information:
   1. Design number or designation of applicable testing agency.
   2. The words "Installed by {contractor's name, address, and phone number}"
   3. The words "Do Not Disturb - Fire Resistance Rated Firestop System".
   4. The words "Notify Building Management of Any Damage".
   5. Date of installation.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform on-site special tests and inspections per the Statement of Special Inspections and to prepare reports.
   1. Notify Owner's testing and inspection agency at least seven days in advance of firestop system installations; confirm dates and times on day preceding each series of installations.
   2. Do not cover or conceal firestopping installations until after inspection reports are issued and installations comply with requirements.

B. Field Tests and Inspections: Inspect firestopping per IFC Inspection Guidelines for Penetration Firestop Systems and Fire Resistive Joint Systems in Fire Resistance Rated Construction, to determine, in general, that firestopping has been installed in compliance with requirements of tested and listed firestop system.
      a. Frequency: Randomly witness minimum 10 percent of each type firestop, or test by destructive verification method minimum 2 percent of each type firestop per floor or for each area of 10,000 sq. ft. of gross floor area.
      a. Frequency: Randomly witness minimum 5 percent of total length of each type firestop, or test by destructive verification method minimum one sample for each 500 lineal feet of each type firestop.

C. Where deficiencies are found or firestop systems are damaged or removed due to testing, repair or replace firestopping so it complies with requirements of tested and listed system design.
   1. In the event the inspector finds a 10 percent variance in the installed firestop systems, the inspector will stop the inspection and notify the Contractor who shall re-inspect his own work. Contractor shall notify the inspector when the work is ready to be re-inspected. Contractor shall pay costs for additional inspections.

D. Proceed with enclosing or otherwise concealing firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
1. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses. Use methods and cleaning materials approved in writing by manufacturers of firestopping products and that do not damage materials in which firestopping occurs.

B. Waste Management: Per Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL" and as follows:
1. Maintain empty containers, wrappings or boxes of the specified materials to allow inspectors to ascertain sufficient amount of materials have been installed.
2. Dispose of waste containers only after inspection reports are issued and installations comply with requirements.

C. Protect firestopping during and after curing period from contact with contaminating substances.

3.06 PROTECTION

A. Per Div. 01 Section "EXECUTION."

B. Provide final protection and maintain conditions during and after installation that ensure firestop systems are without damage or deterioration at time of Substantial Completion.

C. If, despite protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestop systems and install new materials to produce firestop systems complying with specified requirements.

D. Engage original installer to repair or replace damaged, deteriorated, or defective work. Repair damage which occurred subsequent to installation and prior to final inspection at no cost to the Owner. Restore the Work to a condition free of damage and deterioration at time of Substantial Completion.

3.07 ATTACHMENTS

A. Schedule: Refer to separate “Firestopping Schedule” to be completed by trade or trades installing firestopping.

END OF SECTION 07 84 00
The following items require the attention of the Contractor for completion or correction. Submit separate form for each Subcontractor responsible for installing firestopping. Add additional rows as required. Failure to include any items on this list does not alter the responsibility of the Contractor to complete all Work in accordance with the

<table>
<thead>
<tr>
<th>Design Number (A)</th>
<th>Mfg's I.D. and Manufacturer (B)</th>
<th>Penetrating Item Description: Material, Size, Insulated, Combustible (C)</th>
<th>Annular Space / Opening (D)</th>
<th>Construction (E)</th>
<th>Fire Resistance Rating (F)</th>
<th>F-rating (G1)</th>
<th>T-rating (G2)</th>
<th>L-rating CFM/SF (G3)</th>
<th>W-rating (G4)</th>
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Through Penetrations - Horizontal Assemblies

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Through Penetrations - Wall and Partition Assemblies

|                  |                                 |                                                             |                             |                |                           |               |               |                   |               |
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Membrane Penetrations - Wall and Partition Assemblies

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<tr>
<th>Design Number (A)</th>
<th>Mfg's I.D. and Manufacturer (B)</th>
<th>Joint Width Min. / Max. (D)</th>
<th>Adjacent Construction (both sides of joint) (E)</th>
<th>Fire Resistance Rating (F)</th>
<th>F-rating (G1)</th>
<th>T-rating (G2)</th>
<th>L-rating CFM/SF (G3)</th>
<th>W-rating (G4)</th>
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<th>Firestopping Product Manufacturer(s):</th>
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Provide information for proposed firestopping as follows:

(A) Indicate design number or other system designator assigned by FM (AG), ITS (DIR), UL (DIR), UL (FRD), or other testing laboratory acceptable to authorities having jurisdiction.
(B) Indicate manufacturer's system designator, if any. Include reference numbers and drawing numbers, if any.
(C) Identify the various types of penetrating items (i.e. pipe, vent, conduit, cable tray, etc.) and, for piping, indicate if dry (normally empty) or wet (normally filled) type. Include a material description (i.e. metal, plastic, EMT, etc.) and size (length by width or diameter). State whether the penetrating item is externally insulated or not. State whether the penetrating item is combustible or non-combustible.
(D) Indicate size limitations for annular space and/or opening and width limitations for joints.
(E) Identify the various types of construction being penetrated. Horizontal Assemblies include fire-resistance-rated floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies. Wall and Partition Assemblies include fire walls, fire-barrier walls, shaft enclosure walls, fire partitions, smoke-barrier walls, and smoke partitions.
- 1. Warded description of construction may be omitted if Architect's wall type designator is used (i.e. Wall 3A instead of metal stud & gypsum board).
- 2. For joints, indicate the types of construction at each side of joint beginning each joint with the following abbreviations:
  a. FF for Floor to Floor joints
  b. FW for Floor to Wall joints
  c. HW for Head of Wall joints
  d. WW for Wall to Wall joints
  e. CW for the Perimeter Fire Barrier System at the intersection of a fire-resistance-rated floor assembly and an exterior curtain wall assembly
(F) Identify the fire resistance rating of the assembly in minutes if less than one hour or hours if one hour or longer as indicated on the Drawings.
(G) System Ratings: Indicate the F-Rating, T-Rating, L-Rating, and W-Rating when installed and tested in accordance with standards specified.

END OF FORM 07 84 00.13

C:/Dropbox/ABA/Specifications Projects/2022/2022.514 DPSCD PS/104 Spec/2022-06-09_90% IR & 06-16 100%/07 84 00.13_wsx firestopping systems schedule form.xlsx/FIRESTOPPING SYSTEMS SCHEDULE
SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes joint sealants for scheduled applications, including those specified by reference to this Section.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 02 through 49 Sections specifying sealant products by referencing this Section.
   4. Div. 04 Section "MASSONRY RESTORATION" for masonry control and expansion joint fillers and gaskets.
   5. Div. 07 Section "FIRESTOPPING" for sealing penetrations and joints in fire-resistance-rated construction.
   6. Div. 07 Section "JOINT SEALANTS" for sealing joints in exterior pavements, walkways, and curbing.

1.02 REFERENCES

A. Reference Standards: Perform Work per standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   3. Sealant, Waterproofing and Restoration Institute (SWRI):
      a. SWR Institute Currently Validated Products Listing; http://www.swrionline.org/ValidatedSealants.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Sequencing and Coordination: Per Div. 01 Section "PROJECT COORDINATION."

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. Where not indicated in preprinted technical data sheets, include the following:
1. Characteristics per Joint Sealant Products Schedule, plus VOC content, hardness after
cure and after 5 years, cure time, shrinkage percent, application temperature limits,
minimum and maximum joint dimensions, and color availability.
2. List of backing materials approved for use with the specific product.
3. Substrates that product is known to satisfactorily adhere to and with which it is
compatible.
4. Substrates the product should not be used on.
5. Substrates for which use of primer is required.
6. Substrates for which laboratory adhesion and/or compatibility testing is required.
7. Manufacturers’ installation instructions, including precautions, limitations, and
recommended backing materials and tools.
3. Sample warranty.

B. Samples: For each type and color of sealant exposed to view in the finished Work.
1. Where Standard Colors are Scheduled: Submit manufacturer's color cards showing the
standard colors available for initial selection.
2. Where Custom Colors are Scheduled: Submit cured sealant samples in 1/2 inch wide
joints formed between 6-inch long strips of actual building material adjacent to joint
sealants.
   a. With Architect's prior approval, alternate materials matching the appearance of
      adjacent surfaces may be used instead of actual material where strips of actual
      material are impractical or unwieldy.

C. Proposed Product Schedule: Assign a unique identifier to each sealant product proposed for
use cross-referenced to Joint Sealant Products Schedule. List each specific joint location cross-
referenced to Joint Sealant Usage Schedule. For joints with dissimilar substrates, indicate
substrates on both sides of joint. Correlate schedule with each sealant product and color
proposed for use with unique identifying number.
1. Prepare separate schedules for each trade responsible for installing sealants showing
   those locations within their scope of responsibility.
2. In addition, indicate the following:
   a. Substrates where primers are required, or indicate as "No primer required."
   b. Joint width as indicated in Contract Documents.
   c. Joint depth as indicated in Contract Documents; to face of backing material at
centerline of joint.
   d. Masking method to be used.
   e. Planned date of installation from Contractor's Construction Schedule, for
evaluation of thermal movement influence.

1.06 INFORMATION SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
1. Installer's certificate.
2. Product certificates.
3. SWRI validation certificates.

B. Test and Evaluation Reports:
1. Manufacturer's product test reports. Include with product data submittal.
2. SWRI validation test results.
3. Preconstruction laboratory test reports.
4. Preconstruction field adhesion test reports.
   a. Include copies of each test method protocol used.
   b. Include digital photographic record of tests if requested.
   c. Include bagged samples of destructively tested sealants.
5. Field adhesion inspection and test reports.
07 92 00 - 3
JOINT SEALANTS

1.07 CLOSEOUT SUBMITTALS

A. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Installation Log: Include the following with Installer's certificate.
1. Prepare separate log for each trade responsible for installing elastomeric sealants showing locations within their scope of responsibility.
2. Unique identification of each length or instance of sealant installed.
3. Location on Project by elevation and floor level.
4. Installer's company name and individual installer's name.
5. Date of installation.
6. Substrate material. For joints with dissimilar substrates, identify each substrate.
7. Backing material used including size.
8. Sealant used with manufacturer, product name/number, color, and lot number.
9. Published movement class of sealant.
10. Primer used, or indicate as "No primer" used.
11. Actual joint width; indicate maximum and minimum width encountered.
12. Actual joint depth to face of backing material at centerline of joint.
13. Air temperature.

1.08 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
1. Installer Qualifications: Minimum 5 years experience under current organizational structure.
   a. Company: An authorized representative who is trained and approved by manufacturer for installation of Products specified in this Section.
   b. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
2. Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS"
3. Manufacturer's Technical Representative Qualifications: Minimum 5 years experience with manufacturer of Products specified in this Section.

B. Manufacturer's Product Testing: Based on comprehensive testing of current product formulations within a 3 year period preceding commencement of the Work and indicating that sealants comply with requirements.
1. Test elastomeric joint sealants per ASTM C920 and per SWRI's Sealant Validation Program.
2. Test solvent-release joint sealants per ASTM C1311.
3. Test latex sealants per ASTM C834. In addition, test acoustical sealants per ASTM E90.

C. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
1. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
2. Deliver to manufacturer samples of materials that will contact elastomeric sealants in sufficient quantities for testing as follows:
3. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
4. Report the following on form modeled after sample form in test method document:
   a. Test results with interpretation.
   b. Manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.

5. Testing is not required if sealant manufacturer submits data based on previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility with substrates matching those submitted.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, engage a qualified testing agency to perform on-site testing per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Locate test joints on actual construction where directed by Architect.
   2. Notify Architect 7 days in advance of dates and times when joints will be tested. Arrange for sealant manufacturer's technical representative to be present.
   3. Test one sample of each combination of elastomeric sealant type and substrate.
   4. Test Method: Test joint sealants per ASTM C1521, Method A. When failure does not occur, continue testing each location per ASTM C1521, Method B pulling at 90 degree angle. Test separate areas per ASTM C1521, Flap Procedure.
      a. For joints with dissimilar substrates, test adhesion to each substrate separately.
   5. Report results on form modeled after sample Field Adhesion Report Form in ASTM C1521. In addition, include the following:
      a. Testing agency and individual technician's name.
      b. Date sealant in test sample was installed and ambient conditions (weather, air temperature, substrate surface temperature) at time of installation.
      c. Installer's company name and individual installer's name.
      d. Substrate material and backing type. For joints with dissimilar substrates, make separate entries for each substrate.
      e. Sealant manufacturer, product name/number, color, and lot number. Include chemistry, stated type, grade, and movement class in manner similar to JOINT SEALANT PRODUCTS SCHEDULE.
      f. Whether or not a primer was used.
      g. Indicate whether a new test or a retest.
   6. Take before and after photos of each destructive test location. Mark adjacent masking tape legibly with lengths and types of anomalies, as well as the joint location.
      a. Append file name(s) of digital photographic record of test.
   7. Place samples of destructively tested sealants in sealed plastic bags, labeled with the location from which the sample was removed, date removed, results of method and Project identification. Store samples in a secure location prior to submittal.
   8. Evaluation of Test Results:
      a. Sealants that fail cohesively will be considered satisfactory if no other indications of noncompliance with requirements are observed.
      b. For sealants that fail adhesively, obtain manufacturer’s written recommendations for primers and substrate preparation needed for proper adhesion and retest until satisfactory adhesion is obtained.
         1) Do not use sealants that persistently fail to adhere to joint substrates during testing.

1.09 DELIVERY, STORAGE, AND HANDLING
A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.10 FIELD CONDITIONS
A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Do not install joint sealants where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

1.11 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard "CLOSEOUT PROCEDURES" as follows:
   1. Silicone Sealants: 20 years from date of Substantial Completion.
   2. Urethane Sealants: 5 years from date of Substantial Completion.
   3. Polysulfide Sealants in Non-Immersion Service: 5 years from date of Substantial Completion.
   4. Polysulfide Sealants in Immersion Service: 1 year from date of Substantial Completion.
   5. Moisture Resistant Silicone Sealants: 2 years from date of Substantial Completion.
   6. Butyl, Latex, and Acoustical Sealants: 1 year from date of Substantial Completion.

C. Specified Warranty: Furnish installer's 2 year warranty on form specified at end of Section.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. See attached Joint Sealant Products Schedule for acceptable sealant manufacturers and products.

   1. Comparable products by other manufacturers will be considered.

2.03 PERFORMANCE CRITERIA

A. Provide joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

2.04 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates.

B. Joint Width: Provide joint sealants suitable for joint sizes per manufacturer's published minimum and maximum joint widths and depths.

C. Colors: As scheduled.

2.05 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Per ASTM C920 and other requirements specified. Elastomeric sealants include, but not limited to, silicone, urethane, polysulfide, and silyl-terminated polyether (STPE).

   1. Type:
a. Provide Type M (multicomponent) sealants where required to achieve color match indicated and where specifically indicated.
b. Provide Type S (single component) or Type M (multicomponent) sealants elsewhere.

2. Grade:
   a. Provide Grade P (pourable self-leveling) or Grade NS (nonsag) sealants at horizontal joints.
   b. Provide Grade NS (nonsag) sealants at vertical and non-horizontal joints.

3. Class: Provide sealants suitable for anticipated joint movement.

4. Use Related to Exposure:
   a. Provide Use T (traffic) at horizontal traffic surfaces.
   b. Provide Use NT (nontraffic) or T (traffic) at vertical and horizontal non-traffic surfaces.
   c. Provide Use I (immersible) per ASTM C 1247 at joints subject to continuous immersion.

   1) Do not use silicone sealants for immersion applications.

5. Use Related to Joint Substrates: Provide sealants suitable for contact with joint substrates indicated.
   a. Provide nonstaining sealants at porous substrates when tested per ASTM C 1248.
   b. Provide sealants suitable for contact with food per 21 CFR 177.2600 where sealants are indicated for joints that will come in repeated contact with food.
   c. Provide sealants that accept paint coatings over cured sealant, with no adverse affects to the applied paint, where joint sealants are indicated to be painted.
   d. Do not use acid-curing silicone sealants in contact with galvanized steel, marble, cement-based materials, copper, and other materials and finishes which may be corroded by sealant formulations.
   e. Provide mildew-resistant sealants, formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth, where indicated.
   f. Provide fire-protection-rated glazing sealants identical to products used in test assemblies to obtain fire-protection rating where indicated for use in fire-protection-rated glazing joints.

2.06 NON-ELASTOMERIC JOINT SEALANTS

A. Butyl-Rubber-Based Solvent-Release Joint Sealant: ASTM C1311.

B. Acrylic-Latex and Siliconized Acrylic-Latex Sealants: ASTM C834, Type OP (opaque), Grade NF; provide manufacturer’s standard nonsag, paintable, nonstaining latex sealant.

C. Acoustical Joint-Sealant: Provide products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies per ASTM E90.
   1. For Exposed and Concealed Joints: ASTM C834; manufacturer’s standard nonsag, paintable, nonstaining latex acoustical sealant.

2.07 JOINT-SEALANT BACKING

A. Cylindrical Cellular Foam Rod: ASTM C1330, with surface that sealants will not adhere to; nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; recommended by sealant and backing manufacturer for intended application; of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   1. For horizontal joints use Type C or B.
   2. For glazing joints use Type O.
2.08 MISCELLANEOUS MATERIALS

A. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

B. Joint Cleaners: Non-corrosive, non-staining type recommended by sealant manufacturer; compatible with joint forming materials.

C. Masking Tape: Self-adhesive, nonstaining, nonabsorbent, removable without adhesive residue, compatible with joint forming materials.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
1. Examine joints to receive sealants, including condition of existing joints within the area of Work, with Installer present.
2. Immediately before installing sealants, clean, mask, and prime joint substrates per ASTM C1193 and sealant manufacturer's written instructions.
3. Perform preconstruction field-adhesion testing as specified in Part 1 Quality Assurance.
   a. After completion of testing, remove remaining test sample material and prepare joints for new sealant installation.

3.02 REMOVING EXISTING SEALANTS

A. Where existing sealant is damaged or indicated to be removed and replaced perform the following steps:
1. Where existing sealant is damaged and where adhesion to substrate is unacceptable:
   a. Mechanically remove existing sealant cleanly from joint.
   b. Install new sealant as specified for new work.
2. Where existing sealant is still well adhered to substrate:
   a. Remove damaged portion utilizing a V-cut leaving well-adhered existing sealant to remain in joint. Remove surface contaminants with solvents as recommended by sealant manufacturer utilizing the two rag wipe method, and allow solvent to dry.
   b. Install new sealant over cleaned areas as specified for new work.

3.03 INSTALLATION

A. Install joint backings, bond-breaker tape, and sealants per recommendations in ASTM C1193 and sealant manufacturer's written instructions as applicable to materials, applications, and conditions indicated. Additionally:
1. Install acoustical sealants per recommendations in ASTM C919.
2. Install glazing sealants per Div. 08 Section "GLAZING."

B. Tooling of Nonsag Sealants: Per ASTM C1193 with joint configurations as follows, unless otherwise indicated:
1. At pedestrian traffic joints: Recessed.
2. At vertical and horizontal non-pedestrian traffic joints: Concave.
3.04 FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare reports.

C. Testing Services: Testing and inspecting of completed installation of joint sealants shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installation of sealant work for the next area until test results for previously completed installations of sealant work show compliance with requirements.

D. Field Inspections:
   1. Evaluate installer's quality-control and testing methods.
   2. Visual inspect entire length of each sealant joint for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results for observed and suspected defects in a manner similar to field-adhesion-test reports.
   3. At end of construction period, or at a time when remaining construction work will in no way affect or endanger work in place, require installer to make a final inspection of work of this Section and prepare a written report to Contractor, with copy to Architect, describing nature and extent of deterioration or damage found in the work.

E. Field Tests: Arrange for assistance of a factory-authorized service representative.
   1. Test completed, fully-cured, elastomeric joint-sealants for adhesion to joint substrates per ASTM C1521 as follows:
      a. Extent: Perform procedure where visual inspection indicates sealant may not be properly installed or adhered.
      b. Frequency: Perform Technique 1 procedure every 12 inch for first 10 linear feet of joint. If no test failure is observed in the first 10 linear feet of joint tested, test every 24 inch thereafter. If test failure is observed in the first 10 linear feet of joint tested, test every 12 inch thereafter at no additional cost to Owner for the increase in test frequency.
      c. Notify Architect immediately if any test failure is observed in the first 100 linear feet of joint tested.
   2. Non-Destructive Spot Procedure: Per ASTM C1521, Technique 1, depressing sealant approximately 50 percent of the width of the sealant bead.
      a. Extent: Perform procedure where visual inspection indicates sealant may not be properly installed or adhered.
      b. Frequency: Perform Technique 1 procedure every 12 inch for first 10 linear feet of joint. If no test failure is observed in the first 10 linear feet of joint tested, test every 24 inch thereafter. If test failure is observed in the first 10 linear feet of joint tested, test every 12 inch thereafter at no additional cost to Owner for the increase in test frequency.
      c. Notify Architect immediately if any test failure is observed in the first 100 linear feet of joint tested.
   3. Destructive Tail Procedure: Per ASTM C1521, Method A. When failure does not occur, continue testing each location per ASTM C1521, Method B pulling at 90 degree angle.
      a. Extent: Extend test strip to include joint configuration.
      b. Frequency: At new sealant joint, perform procedure every 100 linear feet for first 1,000 linear feet of joint. If no test failure is observed in the first 1,000 feet of joint, perform procedure every 1,000 linear feet thereafter but not less than once per floor per elevation. If any failures occur in the first 1000 linear feet, continue testing at frequency of one test per 500 linear feet at no additional cost to Owner for the increase in test frequency.
      c. Notify Architect immediately if any test failure is observed in the first 1,000 linear feet of joint tested.
a. Extent: Each different sealant and substrate combination where joints are 5/8 inch wide or more and where joints are 1/2 inch deep or less.
b. Frequency: One test for each sealant and substrate combination. For joints with dissimilar substrates, verify adhesion to each substrate separately.

5. Report results of each test on form modeled after sample Field Adhesion Report Form in ASTM C1521. In addition, include the following:
   a. Testing agency and individual technician's name.
   b. Date sealant in test sample was installed and ambient conditions (weather, air temperature, substrate surface temperature) at time of installation.
   c. Installer's company name and individual installer's name.
   d. Substrate material and backing type. For joints with dissimilar substrates, make separate entries for each substrate.
   e. Sealant manufacturer, product name/number, color, and lot number. Include chemistry, stated type, grade, and movement class in manner similar to JOINT SEALANT PRODUCTS SCHEDULE.
   f. Whether or not a primer was used.
   g. Indicate whether a new test or a retest.

6. Take before and after photos of each destructive test location. Mark adjacent masking tape legibly with lengths and types of anomalies, as well as the joint location.
   a. Append file name(s) of digital photographic record of test.

7. Place samples of destructively tested sealants in sealed plastic bags, labeled with the location from which the sample was removed, date removed, results of method and Project identification. Store samples in a secure location prior to submittal.

8. Repair destructively tested areas by methods recommended by sealant manufacturer. Applying new sealants to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

9. Evaluation of Field Test Results:
   a. Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory.
   b. Remove and replace sealants that fail to adhere to joint substrates during testing or that fail to comply with other requirements. Retest failed applications until test results show sealants comply with indicated requirements. Perform removal, replacement, and retesting at no additional cost to Owner.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. 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.
3.07 ATTACHMENTS

A. Refer to separate “JOINT SEALANT USAGE SCHEDULE” for sealant types by areas of application and color selection.

B. Refer to separate “JOINT SEALANT PRODUCTS SCHEDULE” for acceptable products by type, grade, class, exposure, and substrates.

END OF SECTION 07 92 00
SEALANT INSTALLER'S WARRANTY

WHEREAS ____________________________ (Installer's name)
of ____________________________ (Installer's address),
herein called the "Sealant Installer," has performed weatherproofing sealant and associated work ("work") on the following Project:

Owner: ____________________________ (Owner's name)
Address: ____________________________ (Owner's address)
Building Name/Type: ____________________________ (Insert information)
Address: ____________________________ (Insert address)
Area of Work: ____________________________ (Insert information)
Acceptance Date:

Warranty Term: Two (2) years from date of Substantial Completion of Project
Commencement Date: ____________________________ Expiration Date: ____________________________

AND WHEREAS Sealant Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period, NOW THEREFORE Sealant Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

This Warranty is made subject to the following terms and conditions:

1. Specifically included in this Warranty are repairs to or replacements of sealant which has failed in materials or workmanship.
2. Specifically excluded from this Warranty are deterioration or failure of joint sealants, damages to work and other parts of the building, and to building contents, caused by: a) fire; b) movement of the structure causing stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression; c) faulty construction of joint substrates; d) failure of joint substrates including cracking, settlement, deterioration, and decomposition from causes exceeding design specifications, e) mechanical damage caused by individuals, tools, or other outside agents including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner, and f) changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
3. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Sealant Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
4. Sealant Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
5. During Warranty Period, if Owner allows alteration of work by anyone other than Sealant Installer, including cutting, patching, and maintenance, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Sealant Installer to perform said alterations, Warranty shall not become null and void unless Sealant Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
6. Owner shall promptly notify Sealant Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Sealant Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Sealant Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of sealant failure. Specifically, this Warranty shall not operate to relieve Sealant Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

IN WITNESS THEREOF, this instrument has been duly executed this ____________ day of ____________, ____________.

07 92 00 - 11
JOINT SEALANTS
<table>
<thead>
<tr>
<th>Joint Location</th>
<th>Acceptable Chemistry</th>
<th>Class</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOINT SEALANT USAGE SCHEDULE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Exterior Horizontal Traffic Joints (landings, sidewalks, plazas, etc.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation &amp; contraction joints in concrete slabs, cast-in-place</td>
<td>S</td>
<td>100/50</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between concrete paving &amp; walls &amp; other vertical surfaces</td>
<td>S</td>
<td>100/50</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Exterior Vertical &amp; Horizontal Non-Traffic Joints</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, clay</td>
<td>S, PE</td>
<td>50</td>
<td>Custom</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, concrete, painted</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, concrete, un unfinished</td>
<td>S</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, stone (natural, cast &amp; manufactured)</td>
<td>S</td>
<td>50</td>
<td>Custom</td>
</tr>
<tr>
<td>Joints between expansion joints in unit masonry, stone (natural &amp; cast)</td>
<td>S</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Transition joints between air barrier</td>
<td>S, PE</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in direct-applied finish systems</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between metal flashings, concealed tapped joints</td>
<td>PE, PU</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between metal flashings, exposed, prefinished</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between metal flashings, exposed, un unfinished</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between metal panels, prefinished</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Perimeter joints around frames, metal, painted</td>
<td>PE, PU</td>
<td>50</td>
<td>Custom</td>
</tr>
<tr>
<td>Perimeter joints around frames, metal, prefinished</td>
<td>PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Setting bed for flashing receivers</td>
<td>B</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td>Setting bed for thresholds &amp; sills</td>
<td>B</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td>Setting bed for metal flashing &amp; metal frames</td>
<td>B</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Interior Horizontal Traffic Joints</strong></td>
<td>None required</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Isolation &amp; contraction joints in concrete slabs, concealed or covered with other flooring</td>
<td>PE, PU</td>
<td>25</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in terrazzo flooring</td>
<td>PE, PU</td>
<td>25</td>
<td>Custom</td>
</tr>
<tr>
<td>Control &amp; expansion joints in resinous flooring</td>
<td>PE, PU</td>
<td>25</td>
<td>Custom</td>
</tr>
<tr>
<td><strong>Interior Vertical &amp; Horizontal Non-Traffic Joints</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control &amp; expansion joints in cast-in-place concrete</td>
<td>U</td>
<td>25</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, clay</td>
<td>U</td>
<td>25</td>
<td>Custom</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, concrete, painted</td>
<td>U</td>
<td>25</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in unit masonry, concrete, un unfinished</td>
<td>U</td>
<td>25</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints in &amp; between plastic laminate &amp; adjacent surfaces</td>
<td>L</td>
<td>S</td>
<td>Custom</td>
</tr>
<tr>
<td>Perimeter joints around frames, metal, painted</td>
<td>L</td>
<td>S</td>
<td>Custom</td>
</tr>
<tr>
<td>Control joints in gypsum board ceilings &amp; partitions</td>
<td>L</td>
<td>7½</td>
<td>Standard</td>
</tr>
<tr>
<td>Penetrations and joints in fire-resistance-rated construction</td>
<td>Firestopping per 07 84 00 - movement capability to suit joint movement potential</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Control joints in acoustic walls &amp; partitions including gaps at electrical outlets, penetrations, and other openings</td>
<td>A</td>
<td>5</td>
<td>Standard</td>
</tr>
<tr>
<td>Control &amp; expansion joints in ceramic tile</td>
<td>S, PE, PU</td>
<td>25</td>
<td>Custom</td>
</tr>
<tr>
<td>Joints in &amp; between countertops &amp; adjacent surfaces</td>
<td>S, PE, PU</td>
<td>50</td>
<td>Standard</td>
</tr>
<tr>
<td>Joints between plumbing fixtures, food preparation fixtures, casework &amp; adjacent walls, floors, &amp; counters</td>
<td>MR</td>
<td>25</td>
<td>White</td>
</tr>
<tr>
<td>Setting bed for thresholds &amp; sills</td>
<td>B</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td>Setting bed for metal &amp; wood frames</td>
<td>B</td>
<td>1½</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Glazing Joints</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hollow metal frames to glass, cap bead</td>
<td>PE, PU</td>
<td>50</td>
<td>Custom</td>
</tr>
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</table>
## Colors of Exposed Joint Sealants:

<table>
<thead>
<tr>
<th>Color Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Color</td>
<td>As selected by Architect from manufacturer’s full range for this characteristic.</td>
</tr>
<tr>
<td>Custom Color</td>
<td>Provide a custom color matching Architect’s sample that complies with requirements.</td>
</tr>
</tbody>
</table>

END OF SCHEDULE 07 92 00.13
## JOINT SEALANT PRODUCTS SCHEDULE

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>PRODUCT Description</th>
<th>CHEMISTRY</th>
<th>TYPE</th>
<th>GRADE</th>
<th>MOVEMENT CLASS</th>
<th>USE RELATED TO</th>
<th>EXPOSURE</th>
<th>SUBSTRATE</th>
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</thead>
<tbody>
<tr>
<td>USG</td>
<td>Firecode Smoke-Sound Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>M</td>
</tr>
<tr>
<td>USG</td>
<td>SHEETROCK Acoustical Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>M</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>AC-20 FTR Acoustical and Insulation Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>7/8</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>AIS-919 Acoustical and Insulation Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>7/8</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Specified Technologies</td>
<td>SpecSeal Smoke 'N Sound Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>N/A</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Tremco</td>
<td>Tremco Acoustical Sealant</td>
<td>Acoustical</td>
<td>S</td>
<td>NS</td>
<td>N/A</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>8C-158 Butyl Rubber Sealant</td>
<td>Butyl</td>
<td>S</td>
<td>NS</td>
<td>7½</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Tremco</td>
<td>Tremco Butyl Sealant</td>
<td>Butyl</td>
<td>S</td>
<td>NS</td>
<td>7½</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>BA-98</td>
<td>Butyl</td>
<td>S</td>
<td>NS</td>
<td>5</td>
<td>--</td>
<td>NT</td>
<td>A</td>
</tr>
<tr>
<td>BASF Const. Chemicals</td>
<td>MasterSeal NP100</td>
<td>Hybrid</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>T</td>
<td>NT</td>
<td>M-A-O</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>Dynatrol I-XL Hybrid</td>
<td>Hybrid</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>T</td>
<td>--</td>
<td>M-G-A-O</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>Lexon H1 Low Modulus Hybrid Sealant</td>
<td>Hybrid</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
<td>NT</td>
<td>M-A-O</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>AVW-920 High Performance Acrylic Latex</td>
<td>Latex</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>Till-Seal High Performance Acrylic Latex</td>
<td>Latex</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
</tr>
<tr>
<td>Tremco</td>
<td>Tremflex 834</td>
<td>Latex</td>
<td>S</td>
<td>NS</td>
<td>12%</td>
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<td>NT</td>
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</tr>
<tr>
<td>Pecora Corp.</td>
<td>AC-20+Silicone</td>
<td>Latex</td>
<td>S</td>
<td>NS</td>
<td>7½</td>
<td>--</td>
<td>NT</td>
<td>--</td>
</tr>
<tr>
<td>BASF Const. Chemicals</td>
<td>Sonolastic 150</td>
<td>MR Silicone</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
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<tr>
<td>Pecora Corp.</td>
<td>968 NST</td>
<td>MR Silicone</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
</tr>
<tr>
<td>Dow Corning Corp.</td>
<td>786 Silicone Sealant</td>
<td>MR Silicone</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>G-A-O</td>
</tr>
<tr>
<td>Tremco</td>
<td>Tremsil 200</td>
<td>MR Silicone</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>G-A-O</td>
</tr>
<tr>
<td>Pecora Corp.</td>
<td>890 FTS</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>100/50</td>
<td>--</td>
<td>NT</td>
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<td>Dow Corning Corp.</td>
<td>DOWSIL 790 Silicone Building Sealant</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>100/50</td>
<td>T</td>
<td>NT</td>
<td>M-G-A-O</td>
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<td>890 NST</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>100/50</td>
<td>--</td>
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<tr>
<td>Sika Corp. U.S.</td>
<td>Sika Sil WS-295</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>100/50</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
</tr>
<tr>
<td>Tremco</td>
<td>Spectrem 2</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>100/50</td>
<td>--</td>
<td>NT</td>
<td>M-G-A-O</td>
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<tr>
<td>Dow Corning Corp.</td>
<td>DOWSIL 756 SMS Silicone Building Sealant</td>
<td>Silicone</td>
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<td>NS</td>
<td>50</td>
<td>--</td>
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<td>M-G-A-O</td>
</tr>
<tr>
<td>Dow Corning Corp.</td>
<td>DOWSIL 791 Silicone Weatherproofing Sealant</td>
<td>Silicone</td>
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<td>NS</td>
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<td>M-G-A-O</td>
</tr>
<tr>
<td>Dow Corning Corp.</td>
<td>DOWSIL 795 Silicone Building Sealant</td>
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<td>NS</td>
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<td>--</td>
<td>NT</td>
<td>G-A-O</td>
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<td>895 NST</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
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<td>Pecora Corp.</td>
<td>864 NST Silicone Sealant</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
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<td>M-G-A-O</td>
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<tr>
<td>Sika Corp. U.S.</td>
<td>Sikasil WS-295</td>
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<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
<td>NT</td>
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</tr>
<tr>
<td>Tremco</td>
<td>Spectrem 2</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>50</td>
<td>--</td>
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<td>Dow Corning Corp.</td>
<td>DOWSIL Contractors Weatherproofing Sealant</td>
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<td>35</td>
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<td>M-A-O</td>
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<tr>
<td>Dow Corning Corp.</td>
<td>DOWSIL 758 Silicone Weather Barrier Sealant</td>
<td>Silicone</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>--</td>
<td>NT</td>
<td>G-A-O</td>
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**DEFINITIONS**

Type: S = Single Component; M = Multiple Component

Grade: NS = Non-Sag; P = Pourable or Self-Leveling

Class: Numerical values represent percent elongation/compression capability; "Min" implies "minimal"

Exposure: T = Traffic; NT = Non-Traffic; I = Immersion Service

Uses: M = Mortar; G = Glass; A = Aluminum; O = Other

END OF SCHEDULE 07 92 00.14
SECTION 07 95 00 - EXPANSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes expansion joint cover assemblies for the following conditions:
   1. Exterior expansion control assemblies.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Section "JOINT SEALANTS" for liquid-applied joint sealants.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type and color of exposed expansion control system for initial selection and verification.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.06 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 2 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Leakage.
   2. Deterioration beyond normal weathering.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.
B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS
A. Manufacturers:
   1. Architectural Art Mfg., Inc.
   2. Balco, Inc.
   1. Construction Specialties, Inc.
   3. MM Systems Corporation.
   4. Watson Bowman Acme Corp.
   5. Comparable products by other manufacturers will be considered.

1.05 PERFORMANCE REQUIREMENTS
A. Expansion joint assemblies shall resist the movements indicated without failure or leaking, due to defective manufacture, fabrication, installation, or other defects in construction.

B. Thermal Performance Requirements:
   1. Provide exterior-exposed expansion joint assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, excessive elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.06 EXPANSION JOINT ASSEMBLIES
A. Provide expansion joint assemblies of design, basic profile, materials, and operation indicated and scheduled. Provide units with capability to accommodate variations in adjacent surfaces.

B. Preformed Silicone-Seal System: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
   1. Products:
      a. 123 Silicone Seal by Dow Corning Corp.
      b. UltraSpan US1100 by GE Silicones.
      c. Sil-Span by Pecora Corp.
      d. Spectrem Simple Seal by Tremco.
   2. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where joint changes direction or abuts other materials.
   3. Include factory-fabricated closure materials and transition pieces and other accessories as required to provide continuous joint systems.

C. Insulation: Where joint systems are exposed to exterior environments, provide factory insulated units or fill void spaces with stuffing insulation as specified in Division 7 Section "Thermal Insulation" or approved equivalent.
1.07 MATERIALS

A. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
   1. Visible Seal Color: As selected by Architect from manufacturer's full range of colors.

PART 2 - EXECUTION

2.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."
B. Apply bituminous coating or other permanent separation as recommended by manufacturer on metal surfaces to protect metals against galvanic action.
C. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
D. Examine openings, inside surfaces of joints, and expansion-control joint system interfaces with other construction, for suitable conditions where expansion joints will be installed.
E. Verify that substrate is sound, dry, smooth, clean, and securely anchored.
F. Proceed with installation only after unsatisfactory conditions have been corrected.

2.02 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.
   1. Secure joints in place, with provisions for required movement. Use sealants and miscellaneous items as required to complete expansion joints.
   2. Install expansion joints true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
   3. Provide for linear thermal expansion of exterior expansion joint materials.
   4. Provide uniform profile of expansion joint throughout their length; do not stretch or squeeze membranes.
   5. Provide uniform, neat seams.
B. Terminate exposed ends of expansion joint assemblies with field- or factory-fabricated termination devices.

2.03 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
B. 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.

2.04 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:
B. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

C. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 00
SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hollow-metal doors and frames of the following types:
   1. Standard units fabricated per ANSI/NAAMM/SDI standards.
   2. Commercial laminated core units fabricated per ANSI/NAAMM/HMMA standards.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 08 Section "DOOR HARDWARE."
   4. Facility Services Subgroup Sections (Div. 20-29) for electrical and electronic safety and security products required to complete work of this Section including, but not limited to, the following:
      a. Rough-ins, conduit, wiring, and connections for power, signal, and control systems.

1.02 REFERENCES

A. Definitions:
   1. Minimum Thickness: Minimum thickness of base metal without coatings per ANSI/SDI A250.8 or ANSI/NAAMM/HMMA 803 and standards specified.

B. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
      a. ANSI/SDI A250.11, Recommended Erection Instructions for Steel Frames.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Review required field quality-control procedures.
   2. Review procedures for coordinating frame and anchor installation with wall construction.
   3. Review frame grouting procedures.

B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   2. Coordinate the installation of power, signal, and control systems with installation of Facility Services utilities.
1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:
   1. Construction details, core descriptions, and material descriptions.
   2. Dimensions of individual components and profiles.
   3. Details of doors, including vertical- and horizontal-edge details and metal thicknesses of components.

C. Shop Drawings: Include the following Project specific drawings and information:
   1. Elevations of each door and frame type. Include core descriptions, temperature-rise ratings, and fire-resistance ratings.
   2. Details of each different wall opening condition.
   3. Locations of reinforcement and preparations for hardware.
   4. Details of frames, including dimensioned profiles and metal thicknesses.
   5. Locations of reinforcement and preparations for hardware; anchorages, joints, field splices, and connections.
   6. Details of accessories.
   7. Details of moldings, removable stops, and glazing.
   8. Details of conduit and preparations for electrically operated and pneumatic door hardware and for power, signal, and control systems.

1.03 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's certificate.
   2. Oversize construction certification for fire rated assemblies that exceed size limitations of labeled assemblies certifying that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Test and Evaluation Reports: As follows:
   1. Product test reports for each type of fire-rated hollow-metal door and frame assembly.

1.04 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. Security Fasteners: Furnish not less than one box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.
   2. Tools: Provide two sets of tools for installing and removing security fasteners.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Comply with ANSI/SDI A250.8 or ANSI/NAAMM/HMMA 840 and standards specified.
   2. Mark each door on top rail with opening number used on Shop Drawings.

B. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.

08 11 13 - 2
HOLLOW METAL DOORS AND FRAMES
C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4 inch high, wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   1. If wrappers on doors become wet, remove cartons immediately. Provide a minimum of 1/4 inch space between each stacked door to permit air circulation.

PART 2 - "CLOSEOUT PROCEDURES"PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE AND DESIGN CRITERIA

A. Comply with ANSI/SDI A250.8, applicable provisions of referenced standards, and as specified herein.

B. Regulatory Requirements:
   1. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board’s ADA-ABA Accessibility Guidelines and ICC A117.1.

C. Fire-Rated Assemblies: Provide units complying with NFPA 252 or UL 10C and installed per NFPA 80 and listed and labeled by a qualified testing agency with fire rating and temperature-rise limits label attached to each fire rated unit.
   1. Door and Frame Assemblies: As indicated on Door Schedule, tested per UL 10C and NFPA 252.
      a. Smoke- and Draft-Control Assemblies: At corridors, smoke barriers, and smoke partitions, provide assemblies tested per UL 1784 and installed per NFPA 105 with gaskets listed and labeled for smoke and draft control. Include the "S" label on fire-rating label of door.
         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.
      b. 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. Sidelights and/or Transoms: In fire door frames where fire protection rating exceeds 3/4 hour, provide frames tested as an assembly per ASTM E119 or UL 263.
   3. Borrowed Lite and Window Assemblies: As indicated on Door or Window Schedule, tested per UL 9 and NFPA 257.

2.03 STANDARD HOLLOW METAL DOORS AND FRAMES

A. Manufacturers: SDI Certified Manufacturers.
   1. Comparable products by other manufacturers will be considered.

B. Project Source Limitations: Obtain standard hollow-metal doors and frames through one source from a single manufacturer for entire Project.

1. Exterior Doors: Extra Heavy-Duty Level 3 and Physical Performance Level A; Model 2 - Seamless.
   a. Face Sheet Thickness: 0.053 inch (16 gage), minimum.
   b. Edge Construction: Continuously welded with no visible seam.
   c. Non-Rated Core Material: Stiffen doors with polysisocyanurate, polyurethane, or polystyrene insulation spanning the full thickness of the door, laminated to each face sheet.
      1) Door R-Value: Not less than 2.5 per ASTM C1363.
   d. Fire-Rated Door Core Material: Mineral board.
      1) Fire Rating: As indicated on Door Schedule.

2. Exterior Frames:
   a. Frame Metal Thickness: 0.067 inch (14 gage), minimum.
   b. Construction: Full profile welded.

3. Interior Doors: Heavy-Duty Level 2 and Physical Performance Level B; Model 1 - Full Flush.
   a. Face Sheet Thickness: 0.042 inch (18 gage), minimum.
   b. Non-Rated Door Core Material: Manufacturer's standard.
   c. Fire-Rated Door Core Material: Mineral board.
      1) Fire Rating: As indicated on Door Schedule.

4. Interior Frames:
   a. Metal Thickness: 0.053 inch (16 gage), minimum.
   b. Construction: Knocked down at new drywall partitions. Slip-on at existing drywall partitions.

2.04 CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Manufacturers: Members of the Hollow Metal Manufacturers Association Division (HMMA) of the National Association of Architectural Metal Manufacturers (NAAMM).
   1. Comparable products by other manufacturers will be considered.

B. Project Source Limitations: Obtain custom hollow-metal doors and frames through one source from a single manufacturer for entire Project.

   1. Exterior Doors:
      a. Face Metal Thickness: 0.053 inch (16 gage) minimum.
      b. Edge Construction: Continuously welded with no visible seam.
      c. Non-Rated Door Core Material: Stiffen doors with polysisocyanurate, polyurethane, or polystyrene insulation spanning the full thickness of the door, laminated to each face sheet.
         1) Door R-Value: Not less than 2.4 per ASTM C1363.
      d. Fire-Rated Door Core Material: Mineral board.
         1) Fire Rating: As indicated on Door Schedule.
   2. Exterior Frames:
      a. Frame Metal Thickness: 0.067 inch (14 gage) minimum.
      b. Construction: Full profile welded.
   3. Interior Doors:
      a. Face Metal Thickness: 0.042 inch (18 gage) minimum.
      b. Edge Construction: Projection, spot, or tack welded and filled without visible seam.
      c. Non-Rated Door Core Material: Stiffen doors with kraft-paper honeycomb spanning the full thickness of the door, laminated to each face sheet.
         1) Door R-Value: Not less than 2.4 per ASTM C1363.
      d. Fire-Rated Door Core Material: Mineral board.
         1) Fire Rating: As indicated on Door Schedule.
4. Interior Frames:
   a. Frame Metal Thickness: 0.053 inch (16 gage) minimum.
   b. Construction: Knocked down at new drywall partitions. Slip-on at existing drywall partitions.

2.05 MATERIALS

A. Metallic-Coated Steel Sheet: Galvannealed per ASTM A653 with coating weight of A40 for Standard or Custom doors and frames. Custom doors and frames may also be galvanized per ASTM A924 with coating weight of A60. Provide for doors in the following locations:
   1. Exterior doors and frames.
   2. Interior doors and frames in high-humidity spaces.
   3. Interior doors and frames in corrosive environments.
   4. Interior doors and frames between conditioned and non-conditioned spaces.
   5. Where indicated.

B. Cold-Rolled Steel Sheet: ASTM A1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications. Provide for doors in the following locations:
   1. Interior doors and frames other than those indicated for metallic-coated steel sheet above.

C. Door Core Materials:
   2. Polyisocyanurate: Rigid, pre-formed, closed cell board, conforming to ASTM C591 (unfaced) or ASTM C1289 (faced).
   3. Polystyrene: Rigid, extruded, closed cell board, 1 pound per cubic foot density minimum, conforming to ASTM C578, Type 1.
   4. Polyurethane: Rigid, cellular type, board conforming to ASTM D1622, or foamed-in-place, 1.8 pound per cubic foot density minimum, containing no urea formaldehyde resins.
   5. Temperature Rise Rated (TRR) Fire Doors: Internal construction in accordance with the individual manufacturer’s listings.

2.06 ACCESSORIES

A. Astragals: Provide overlapping astragal on one leaf of pairs of doors where indicated and where required by NFPA 80 for fire-performance rating. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Jamb and Floor Anchors: Provide anchor type, spacing, and method of attachment per applicable standard.
   1. For slip-on type frames and conditions that do not permit the use of a floor anchor, provide an additional jamb anchor located not more than 8 inches from base of jamb.
   2. Provide floor anchors for mullions.

C. Inserts, Bolts, and Fasteners: Hot-dip galvanized per ASTM A153. Provide power-actuated fasteners in concrete of type suitable for application indicated. Provide countersunk, flat-head screws and bolts where exposed, unless otherwise indicated.

D. Security Fasteners: Operable only by tools produced by fastener manufacturer or other licensed fabricator for use on specific fastener type. Provide drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
   1. Manufacturers:
      a. Acument Global Technologies.
      b. Bryce Fastener.
c. Safety Socket, LLC.
d. Tamperproof Screw Co., Inc.
e. Tamper-Pruf Screws.
2. Drive-System Type: Pinned Torx-Plus.
3. Fastener Strength: 120,000 psi.
4. Socket Flat Countersunk Head Fasteners:
5. Protective Coatings for Heat-Treated Alloy Steel:
a. Zinc and clear trivalent chromium where indicated.

E. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

F. Cementitious Grout for Frames in Masonry Construction: ASTM C476, with a maximum 4 inch slump, per ASTM C143.

G. Gypsum Grout for Frames in Drywall Construction: Setting-type compound per Div. 08 Section "GYPSUM BOARD."

H. Grout Guards: Comply with applicable standard. Provide grout guards at all hardware preparations, electronic items, glazing stop and other screws, and silencer preparations on frames to be set in masonry openings.

I. Corrosion-Resistant 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.

2.07 FABRICATION

A. Field Measurements: Where doors and frames are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. 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.

C. Construct doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

D. Steel Door Fabrication: Provide type and thickness as scheduled.
   1. Door Edge Profile: Manufacturers standard for application indicated.
   2. Top Closures: At exterior doors, provide flush end closure channel of same material as face sheets, with top and door faces aligned. At interior doors, provide inverted closure channel of same material as face sheets, with top and door faces aligned.
   3. Construct hollow metal panels of same construction, performance, and finish as doors.

E. Frame Fabrication: Provide profile and dimension as scheduled.
   1. Fabricate sidelights, transoms, multi-opening assemblies, and borrowed lite window assemblies in profiles and assembly method to match door frame members.
   2. Door Silencers: Except where gasketing is specified, drill door stops to receive three silencers in single door jambs and two silencers in double door heads. Keep holes clear of grout during construction.
F. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

G. Hardware Preparations, Selections and Locations: Per BHMA A156.115 and ANSI/SDI A250.8 or ANSI/NAAMM/HMMA 830 and ANSI/NAAMM/HMMA 831 and standards specified.

H. Tolerances: Fabricate frames to tolerances indicated in applicable ANSI/NAAMM-HMMA standard.

2.08 STEEL DOOR AND FRAME FINISH

A. Factory Primed: Per ANSI/SDI 250.10 and Div. 05 Section "SHOP-APPLIED PRIME COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   2. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

C. 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.

D. Where frames are fabricated in sections because of shipping or handling limitations, field splice by continuously welding face joints. Grind, fill, dress, and finish welds smooth on exposed faces. Repair finish at weld areas to match.

E. Drill and tap doors and frames to receive surface-mounted door hardware.

F. Insulation Filled Frames: Prior to installation, pack insulation tightly in frames in the following locations:
   1. Frames in exterior walls of existing, in-place concrete and masonry.
   2. Non-grouted frames in exterior metal-stud walls.

G. Grout Filled Frames: Prior to installation, prepare frames scheduled to be grout filled as follows:
   1. Apply corrosion-resistant coating to coat inside of frame surfaces in contact with grout in one coat to 15 mil thickness and allow to dry.
   2. Install door silencers in frames before grouting.
   3. Frames in Existing, In-Place Concrete Walls: Pre-fill frames with cementitious grout.
   4. Frames in Masonry Walls: Space between frames and masonry to be solidly filled, in lifts, with cementitious grout by Div. 04 Section "COMMON WORK RESULTS FOR MASONRY." Provide temporary supports for weight of grout at head members until grout has cured.
3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations, approved submittals, and the following:
   1. Frames (all types): Install per NAAMM/HMMA 840.
   2. Standard Hollow Metal Doors and Frames: Install per ANSI/SDI A250.11.

B. Hollow-Metal Frames: Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. Remove spreaders prior to frame installation. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   1. Install fire-rated frames per NFPA 80.
   2. Secure existing opening frames in place with post-installed fasteners with expansion shields or inserts. Shim as required. Fill and make smooth, flush, and invisible on exposed faces.
   3. Anchorage: Set anchorage devices according to details on Shop Drawings and according to anchorage device manufacturer's written instructions.
      a. Masonry Anchors: Coordinate frame installation with masonry setting to allow for solidly filling space between frames and masonry with grout.
      b. Postinstalled Anchors: Drill holes in existing construction at locations to match bolt locations, and install bolt expansion shields or inserts.

C. Installation Clearances and Tolerances: Per specified standards.
   1. Fire-Rated Door Clearances: Per NFPA 80.
   2. Smoke-Control Doors: Install doors and gaskets per NFPA 105.

3.03 REPAIR

A. Repairing Damaged Finishes: Immediately after installation, clean field welds and abraded and other areas where coatings are damaged.
   1. Shop-Primed Surfaces: Paint exposed areas with same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
   2. Galvanized Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer’s written instructions.

3.04 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:
   1. Final Adjustments: Check and readjust doors after hardware installation and 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 and replace defective work, including defective or damaged doors and frames that are warped, bowed, or otherwise unacceptable.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   1. Remove excess, visible grout and other bonding material from hollow-metal work immediately after installation.
SECTION 08 13 16 - ALUMINUM DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes exterior and interior manual-swing entrance doors of the following types:
   1. Glazed aluminum entrance doors.
   2. FRP-faced aluminum entrance doors.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 08 Section "ALUMINUM-FRAMED STOREFRONTS" for framing systems in which entrance doors are installed.
   4. Div. 08 Section "DOOR HARDWARE" for hardware not specified in this Section.

1.02 REFERENCES

A. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Department of Justice (DOJ):
      a. DOJ 2010 ADA (ADA) Standards for Accessible Design
   2. International Code Council (ICC):

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate the installation of aluminum entrances with size, location and preparation of framing systems in which entrances are installed.
   2. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
   3. Coordinate the installation of power, signal, and control systems with installation of Facility Services utilities.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:
   1. Construction details and material descriptions.
   2. Dimensions of individual components and profiles. Include stile and rail member structural and physical characteristics and dimensional limitations.
3. Details of doors, including vertical- and horizontal-edge details and metal thicknesses of components.
4. Details of moldings, removable stops, and glazing.

B. Shop Drawings: Include the following Project specific drawings and information:
1. Elevations of each door type. Include facing material, glazing type, and finish.
2. Details of each different frame condition.
3. Locations of reinforcement and preparations for hardware.
4. Hardware for each door.
5. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification: For each type of exposed finish required for verification.
1. Finish Sample Size: 4 inches square.

D. Product schedule for doors prepared by supplier. Use same designations indicated on Drawings.

E. Entrance Door Hardware Schedule: Complete itemization of each item of hardware to be provided for each door including supplier source (door manufacturer or Div. 08 Section "HARDWARE").

1.06 INFORMATIONAL SUBMITTALS
A. Test and Evaluation Reports: As follows:
1. Product test reports for doors.

B. Sample warranties.

1.07 CLOSEOUT SUBMITTALS
A. Operation and Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.08 MAINTENANCE MATERIAL SUBMITTALS
A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Tools: Furnish one set of each special tool designed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

1.09 QUALITY ASSURANCE
A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of doors required for this Project.
2. Welder Qualifications: AWS certified within past 12 months for each type of weld required.

1.10 DELIVERY, STORAGE, AND HANDLING
A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
1.11 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard 10 year warranty providing coverage against failures in materials or workmanship.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water leakage through fixed glazing areas.
      e. Failure of operating components.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers, FRP-Faced Aluminum Entrance Doors:
   1. 4900 Series by Capitol Aluminum and Glass Corporation.
   2. Series 200BE by Cline Doors.
   3. 170 Series by Manko Window Systems.
   4. SL-17 by Special-Lite, Inc.
   5. Model 25FD by YKK Architectural Products.
   6. Flushline by Kawneer/Traco; an Arconic, Inc. company.

B. Manufacturers, Glazed Aluminum Entrance Doors:
   2. Cline Doors.
   4. Special-Lite, Inc.
   5. YKK Architectural Products.
   6. Kawneer/Traco; an Arconic, Inc. company.

2.03 DESCRIPTION

A. Aluminum Entrance Doors: Factory fabricated and finished aluminum doors including perimeter members, facing material, glass infill, related sealant, operating hardware, anchorage and attachment devices.

B. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they
relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

C. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

2.04 PERFORMANCE / DESIGN CRITERIA

A. Performance, General: Comply with performance requirements specified, as determined by testing manufacturer's standard entrance doors representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum entrances shall withstand the effects of the following without exceeding performance criteria or failure:
   a. Movements of supporting framing.
   b. Dimensional tolerances of supporting framing.

B. Structural Performance Requirements: Provide aluminum doors capable of withstanding, without failure, the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, determined per the following code requirements:

1. Design Wind Loads: As indicated on Drawings.
   a. Measure performance per ASTM E330 using test loads equal to 1.5 times design wind loads and not less than 10 second duration of maximum pressure.

C. FRP Panel and Foam Insulation Core Surface Burning Characteristics: ASTM E84; Class A.

D. Thermal Performance Requirements:

1. Provide doors that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces with interior ambient-air temperature of 75 deg F.
   b. Accommodate movement of supporting framing.
   c. Accommodate deflection of supporting framing under permanent and dynamic loads.

E. Energy Performance: Certify and label energy performance for entrance doors and glazing per NFRC as follows:

1. Thermal Transmittance (U-Factor): U-factor of not more than 0.80 Btu/sq. ft. x h x deg F per NFRC 100.
2. Air Infiltration: Maximum air leakage in the closed and locked position of 1.0 cfm/sq. ft. of door opening as determined per ASTM E283 at a static-air-pressure differential of 1.57 lbf/sq. ft.
3. Solar Heat Gain Coefficient: SHGC of not more than 0.40 per NFRC 200.
2.05 GLAZED ENTRANCE DOORS

A. Glazed Interior Entrance Doors, General: Provide manufacturer’s standard glazed aluminum entrance doors for manual-swing operation.
   1. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
   3. Door Design: Wide stile; 5-inch vertical stile, 5" top and 6-1/2" bottom rail.
      a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
   4. Door Overall Thickness: As indicated. with minimum 0.125 inch thick extruded-aluminum tubular rail and stile members.
   5. Glazing: Monolithic glass per Div. 08 Section "GLAZING."

2.06 FRP-FACED ALUMINUM ENTRANCE DOORS

A. FRP-Faced Doors: Provide manufacturer’s standard FRP-faced aluminum doors for manual-swing operation.
   1. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
   2. Door Design: As indicated.
      a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
   3. Door Faces: Gelcoat-finished, FRP panels complying with ASTM D 5319.
      a. Nominal Thickness: Not less than 0.090 inch.
      b. Texture: Pebblegrain.
      c. Color: Through color as indicated or, if not indicated, as selected from manufacturer's full range.
   4. Door Overall Thickness: As indicated. with minimum 0.125 inch thick extruded-aluminum tubular rail and stile members.
   5. Vision Lite: As indicated.
   6. Door Core: Poured-in-place polyurethane foam of minimum 5 pounds per cubic foot density; and with minimum R-value of 9.

2.07 GLAZING

A. Glazing: As specified in Div. 08 Section "GLAZING."

2.08 HARDWARE

A. Entrance Door Hardware: As specified in Div. 08 Section "DOOR HARDWARE" except as follows:

B. Pulls: Recessed exterior pulls integrated into door body matching Special-Lite SL-86 with clear anodized finish.
C. Weather Stripping: Manufacturer's standard replaceable components.
   1. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.09 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
   3. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Prime steel members as specified in Div. 05 Section "SHOP-APPLIED PRIME COATINGS FOR METAL."
   1. Structural Shapes, Plates, and Bars: ASTM A36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A1011/A 1011M.

2.10 FABRICATION

A. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints. Cope or miter ends of glazing stops and gaskets.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from interior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Door Hardware:
   1. Reinforce doors as required for installing entrance door hardware.
   2. Cut, drill, and tap for factory-installed entrance door hardware.
   3. Factory install entrance door hardware to the greatest extent possible.

D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
2.11 ALUMINUM FINISHES

A. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Install entrance doors plumb and true in alignment without warp or rack.
   1. Install doors to produce smooth operation, weathertight enclosure, and tight fit at weather stripping.
   2. Install hardware indicated for field-installation per hardware manufacturers' written instructions using concealed fasteners when possible.
   3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.

C. Install glazing per Div. 08 Section "GLAZING."

D. Installation Tolerances: Comply with the following non-accumulating maximum tolerances:
   2. Alignment: Plus or minus 1/16 inch from door face to face of framing.
   3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4. Maximum Variation from Plumb: Plus or minus 1/16 inch, measured at jambs at floor.

E. Design Clearances:
   1. Between Door and Frame: Maximum 1/8 inch.
   2. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.

3.03 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:
   1. Adjust operating door hardware to function smoothly as recommended by manufacturer.
   2. For accessible entrances, adjust door closer speed per ADA standards.

END OF SECTION 08 13 16
SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes solid-core wood doors of flush and flush-glazed configurations indicated with wood-veneer faces.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 08 Section "HOLLOW METAL DOORS AND FRAMES" for metal door frames.
   4. Div. 08 Section "DOOR HARDWARE."
   5. Div. 08 Section "GLAZING."

1.02 REFERENCES

A. Abbreviations and Acronyms:
   1. FR: Fire retardant.

B. Definitions:
   1. NAUF: No added urea formaldehyde.
   2. ULEF: Ultra-low emitting formaldehyde.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Coordinate sizes and locations of frames, reinforcements, hardware and other related units of Work specified in other Sections to ensure that doors can be installed as indicated.
   1. Obtain copies of approved hardware submittals for doors; coordinate Shop Drawings and fabrication with hardware requirements.
   2. Obtain templates and directions for installing hardware.
   3. Coordinate installation of doors with installation of frames and hardware.
   4. Coordinate installation of glazing.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of door, including finishing materials and processes.
   1. Include standard details of core and edge construction and trim for openings.

B. Shop Drawings: Per AWMAC/WI (NAAWS) or AWI/AWMAC/WI (AWS) requirements.
1. Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
2. Indicate dimensions and locations of mortises and holes for hardware.
3. Indicate dimensions and locations of cutouts. Include details of moldings and removable stops for glazing. Include details of frames for glazing.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf. Indicate requirements for veneer matching.
5. Indicate doors to be factory finished and finish requirements.
6. Indicate fire-protection ratings for fire-rated doors.

C. Samples for Verification: For each type, surface finish, and color of the following:
   1. Sample Size: Manufacturer's standard.
   2. For factory-finished doors, include corner sections of doors for each finish system applied to one face and one edge. Step back each coat and process at least one inch to show bare substrate and each stain, filler, sealer, undercoat, and topcoat in system build-up. Label each coat of each sample to indicate materials, color, gloss, DFT of each coat applied, and total system DFT.

D. Product schedule for doors prepared by supplier. Use same designations indicated on Drawings. Coordinate with final Door Hardware Schedule.

1.03 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's certificate.

B. Product test reports for each type of the following:
   1. Fire-rated wood doors.

C. Sample warranties.

D. Qualification Statements for manufacturer and door inspector.
   1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
   2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, section 7.2.1.15.4.
   3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAl) certificate.

1.04 CLOSEOUT SUBMITTALS

A. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES".

1.05 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

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FLUSH WOOD DOORS
1. Comply with requirements of referenced standards and manufacturer's written instructions.
2. Package doors individually in plastic bags or cardboard cartons.
3. Mark each door on top rail with opening number used on Shop Drawings.

1.07 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.08 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard warranty providing coverage against failures as follows:
   1. Failures include, but are not limited to, the following:
      a. Delamination of veneer.
      b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Veneer-Faced Wood Door Manufacturers:
   1. Ampco by AJW.
   2. Chappell Door Co.
   3. Eggers Industries.
   4. Haley Brothers, Inc.
   5. Ipik Door Company.
   7. Masonite Architectural.
   10. VT Industries Inc.
   11. Comparable products by other manufacturers will be considered.
B. Source Limitations: Obtain each type of flush wood doors through one source from a single manufacturer for entire Project, unless otherwise acceptable to Architect.

2.03 PERFORMANCE CRITERIA

A. Quality Standard: Comply with ANSI/WDMA I.S. 1A and AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) standards in Grade or Grades specified.
   1. The Contract Documents may contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

B. Performance Duty Level: Per ANSI/WDMA I.S.1-A, except for finish, as follows:
   1. Provide Heavy Duty, unless otherwise indicated.
   2. Provide Extra Heavy Duty for doors to assembly areas, auditorium entries, public toilets, classrooms, gym/locker rooms, and where indicated.
   3. Provide Standard Duty for doors to small, low-usage offices, closets (other than janitor's closets), private toilets, and where indicated.

C. Fire-Rated Doors: Manufacture to comply with NFPA 80; listed and labeled for fire-protection ratings indicated, based on testing at positive pressure per NFPA 252 or UL 10C.
   1. Provide Category "A" Doors evaluated without an edge-sealing system between the door and frame or with a concealed sealing system incorporated into the door edges, including doors in pairs.
   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.

D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing per UL 1784.

2.04 DOORS FOR TRANSPARENT FINISH

A. Interior Solid Core Doors:
   1. Wood Face Requirements for Transparent Finish:
      a. Veneer Grade: A.
      b. Veneer Specie and Cut and Piece Match: As indicated on Drawings.
      c. Veneer Face Match: Balance.
      d. Appearance of Pairs: Pair matched.
   2. Door Construction: 5-ply.
      a. Aesthetic Grade: Custom.
      b. Core Type: Particleboard (PC) or Structural Composite Lumber (SCLC) per ANSI/WDMA I.S. 1A.
         1) Provide Fire Resistant Composite Core (FD) where indicated.
         2) Provide Grade LD-2 NAUF or ULEF particleboard.
   3. Hardware Blocking:
      a. Doors with Closers and Hold-Open Devices: HB-1 top rail.
      b. Doors with Kick, Mop, or Armor Plates: HB-2 bottom rail.
      c. Doors with Mortise Locksets: HB-4 lock blocks.
      d. Doors with Exit Devices: HB-6 center rail or HB-4 lock blocks.
   4. Machining Requirements: Factory Machined for Hardware.
   5. Detailed Requirements:
      a. Wood Beaded Vision Lites:
   6. Finish Requirements:
FLUSH WOOD DOORS

2.05 GLAZING FRAMES

A. Wood Frames: Provide manufacturer's standard wood beads as follows:
   1. At non-fire-rated doors, provide solid wood beads.
   2. At 20-minute fire-rated doors, provide wood beads with concealed metal glazing clips approved for such use.
   3. At 45- to 90-minute fire-rated doors, provide wood-veneered noncombustible beads with concealed metal glazing clips approved for use in doors of fire-rating indicated.
   4. Wood Specie: Match door faces at transparent-finished doors.
   5. ANSI/WDMA I.S.1-A Profile: Option M1 - Recessed Molding, square profile.

B. Glazing: Per Div.08 Section "GLAZING."

2.06 FABRICATION

A. Fabricate doors per door quality standards specified.

B. Factory fit doors to suit frame-opening sizes indicated with clearances per referenced quality standards.
   1. Comply with NFPA 80 for fire-rated doors.

C. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

D. Openings: Cut and trim openings through doors in factory.
   1. Glazed Openings: Trim openings with moldings of material and profile indicated. Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Div. 08 Section "GLAZING."

2.07 FACTORY FINISHING

A. Complete fitting and machining before finishing.

B. Finish doors at factory per AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) standards and as follows.
   1. Finish faces, four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on non-visible edges, cutouts, and mortises.

C. Transparent Finish:
   1. Finish System: WDMA TR-6 or manufacturer's standard water-based stain and ultraviolet (UV) cured polyurethane sealer meeting or exceeding performance standards of System TR-6.
3. Open-Grain Wood Filler: Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine doors and installed door frames before hanging doors. Reject doors with defects.
   2. Verify opening sizes, tolerances, and swing characteristics comply with requirements.
   3. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Hardware: Per Div. 08 Section "DOOR HARDWARE."

B. Install doors per manufacturer's written instructions, specified quality standards, and as indicated.
   1. Install fire-rated doors per NFPA 80.
   2. Install smoke and draft control doors per NFPA 105 requirements.

C. Factory-Finished Doors: Do not field cut or trim doors. If fit or clearance is not correct, replace door.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

3.03 FIELD QUALITY CONTROL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

C. Inspections:
   1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2.
   2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, section 7.2.1.15.

D. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

E. Reinspect repaired or replaced installations to determine if replaced or repaired door installations comply with specified requirements.
F. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.04 ADJUSTING
   
   A. Per Div. 01 Section "EXECUTION" and as follows:
   
   B. Adjust doors and hardware for smooth and balanced door movement. Adjust closers to achieve full closing and latching. Rehang or replace doors that do not swing or operate freely.
   
   C. Replace factory finished doors that are damaged or that do not comply with requirements. Factory finished doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

3.05 CLEANING
   
   A. Per Div. 01 Sections "CLOSEOUT PROCEDURES"

3.06 SCHEDULES
   
   A. See Door Schedule on Drawings for list of doors by size and type.
   
   B. See Div. 08 Section "DOOR HARDWARE" for scheduled hardware for doors.

END OF SECTION 08 14 16
SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
3. Div. 23 Sections for HVAC duct access doors.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate requirements of this Section with type of installation assembly being used for each unit.
2. Coordinate with Facility Services trades for locations of access doors and service controls requiring access.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, fire ratings, materials, individual components, profiles, and finishes.

B. Shop Drawings: Include plans and elevations showing exact position of each access door unit.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 DESCRIPTION

A. General: Fabricate metal wall and ceiling access doors and frames as follows:
1. Door and Frame Material: Steel sheet; nominal 0.0598 inch (16 gage) for non-fire-rated units; nominal 0.0359 inch (20 gage) for fire-rated units.
2. Provide fire-rated access doors when located in fire-rated construction. Fabricate units per manufacturer's label service listing with self-latching doors with automatic closing mechanism.
   a. Fire-Resistance Rating: Not less than required by code based on fire-rating of adjacent construction.
3. Hinges: Manufacturer's standard.
4. Hardware: Provide locking units in areas accessible to students. Provide latching units in areas not accessible to students.
5. Size: As indicated on Drawings or, if not indicated, provide smallest size which allows unrestricted access to concealed work requiring access. Obtain Architect's approval for rectangular sizes.
   a. Nominal size 8 by 8 inch for access to controls etc. requiring one-handed operation within arms length.
   b. Nominal size 12 by 12 inch for access to controls etc. requiring two-handed operation within arms length.
   c. Where upper body access is required (such as above ceilings or beyond arms length) provide nominal 18 by 18 inch size.
   d. Where full body access is required (such as entering a shaft) provide nominal 24 by 24 inch size.
2. Mounting: Provide mounting holes in frames for attachment of units to surrounding construction. Locate mounting holes to be concealed when door is closed.

1.05 PERFORMANCE / DESIGN CRITERIA

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80, listed and labeled, for fire-protection ratings indicated, per NFPA 252 or UL 10B for units installed vertically and per NFPA 288 for units installed horizontally.

1.06 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers:
   1. Acudor Products, Inc.
   2. Babcock-Davis.
   7. Comparable products by other manufacturers will be considered.

B. Flush Access Doors with Exposed Flanges:
   1. Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.

C. Hardware: Furnish number required to hold doors in flush, smooth plane when closed.
   1. Latching Mechanism for Non-Fire-Rated Units: Cam latch operated by screwdriver
   2. Latching Mechanism for Fire-Rated Units: Self-latching door hardware operated by knurled-knob
   3. Lock Mechanism for Non-Fire-Rated Units: Slam latch operated by key.
   4. Lock Mechanism for Fire-Rated Units: Self-locking door hardware operated by key.
      a. For cylinder locks, furnish two keys per lock and key all locks alike.
   5. Provide interior release device for full-body access size units.

1.07 MATERIALS

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

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ACCESS DOORS AND FRAMES
B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Frame Anchors: Same material as door and frame.

D. Inserts, Anchors, and Fasteners: Hot-dip galvanized steel per ASTM A 153/A 153M or ASTM F 2329 of type required to secure access doors to types of supports indicated.

1.08 FABRICATION

A. Provide access door and frame assemblies manufactured as integral units ready for installation complete with required fasteners.

B. Grind exposed welds smooth and flush with adjacent surfaces. Where exposed to view in the completed Work, provide metal materials with smooth, flat surfaces free of blemishes, pitting, seam marks, roller marks, rolled trade names, and roughness.

1.09 FINISHES

A. Steel Finishes: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 2 - EXECUTION

2.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

2.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Position access door units to provide convenient access to concealed equipment and service controls requiring access.

2.03 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Adjust doors and hardware, after installation, for proper operation.

C. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

2.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES."

END OF SECTION 08 31 13
SECTION 08 41 13.16 - FIRE-RATED GLAZED FRAMING AND DOOR ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes fire-rated glazed framing and doors for interior locations.

B. Products Specified in Other Sections for Installation Under This Section: 
   1. Install fire-rated glazing specified in Div. 08 Section "GLAZING."

C. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT MANAGEMENT AND COORDINATION" and as follows:
   1. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   2. Coordinate the installation of power, signal, and control systems with installation of Facility Services utilities.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include standard construction details, material descriptions, dimensions of individual components and profiles, hardware, finishes, and operating instructions.

B. Shop Drawings.
   1. Include full-size isometric details of each vertical-to-horizontal intersection of frame members.
   2. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification: For each type of exposed finish required for verification.
   1. Finish Sample Size: 4 inches square.

D. Product schedule for doors prepared by supplier. Use same designations indicated on Drawings.

E. Door Hardware Schedule: Complete itemization of each item of hardware to be provided for each door including supplier source (door manufacturer or Div. 08 Section "DOOR HARDWARE").
1.05 INFORMATIONAL SUBMITTALS

- A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
  1. Product certificates.

- B. Test and Evaluation Reports: As follows:
  1. Product test reports.

- C. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

- B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.07 QUALITY ASSURANCE

- A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
  1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
     a. Capable of fabricating framing and doors that meet or exceed energy performance requirements indicated and of documenting said performance by certification, labeling, and inclusion in lists.
  2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
     a. Company: An authorized representative of manufacturer whose workers are trained and approved by manufacturer for installation of Products specified in this Section.
     b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
     c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
  3. Welder Qualifications: AWS certified within past 12 months for each type of weld required.

- B. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
  1. Fire Protective Door Assembly Certifications: 20-45 minute fire protective door assemblies shall be tested per NFPA 80, NFPA 252, ASTM E152, ASTM E2074, UL 10B, UL 10C and CAN4-S104.
  2. Fire Protective Sidelight Assembly Certifications: 45 minute fire protective window assemblies shall be tested per NFPA 80, NFPA 257, ASTM E163, ASTM E2010, UL 9 and CAN4-S106.
  3. Fire Resistive Wall Assembly Certifications: 60-minute fire resistive wall assemblies tested per ASTM E119, NFPA 251, UL 263 and ULC-S101.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.09 WARRANTY

- A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."
PART B - WARRANTIES

B. Standard Warranty: Furnish manufacturer's standard 5 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Structural failures including, but not limited to, excessive deflection.
   2. Glass breakage.
   3. Loosening or weakening of fasteners, attachments, and other components.
   4. Failure of operating units.
   5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. SAFTI FIRST, a division of O'Keeffe's, Inc.
   2. Technical Glass Products (TGP).
   3. Comparable products by other manufacturers will be considered.

B. Basis of Design Products:
   1. CMA Doors 20A and 20B with Sidelights: GPX Architectural Series by SAFTI FIRST, a division of O'Keeffe's, Inc.
      a. Glazing Product: SuperClear 45-HS or SuperClear 45-HS-L1 low-iron by SAFTI FIRST
      b. Door Product: 20 Minute Fire Protective Aluminum Single Door
         1) Door Glazing Product: SuperLite I or SuperLite I-XL by SAFTI FIRST
      a. Glazing Product: SuperLite II-XL 60 by SAFTI FIRST
      b. Door Product: 60 Minute Temperature Rise Single Door
         1) Door Glazing Product: SuperLite I or SuperLite I-XL by SAFTI FIRST

2.03 DESCRIPTION

A. Fire-rated framing and doors consist of factory fabricated, factory finished doors and framing members, laboratory tested as fire-rated assemblies complete with glazing and related flashings, anchorage and attachment devices.
   1. Framing: Steel subframes clad with aluminum extrusions.
   2. 20 Minute Doors: Extruded aluminum stiles and rails.

B. Regulatory Requirements:
   1. Accessibility Requirements: Comply with applicable provisions in ADA Accessibility Guidelines (ADAAG) and ICC A117.1.
2.04 PERFORMANCE CRITERIA

A. Fire Performance Requirements: Provide hourly rating as indicated; tested as an assembly including glazing.
   1. Acceptable evidence of compliance includes listing by testing agency acceptable to authorities having jurisdiction.
   2. Identify products with appropriate markings of applicable testing and inspecting agency.

B. Structural Performance Requirements: Provide fire-rated glazed assemblies, including anchorages, capable of withstanding, without failure, the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, determined per the following code requirements:
   1. Movement: Provide fire-rated glazed assemblies, including anchorage, that allow for the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects
      a. Accommodate the following movement without damage to components or deterioration of seals:
         1) Movement of supporting structure.
         2) Deflection of structural support framing under permanent and dynamic loads.
   2. Accommodate dimensional tolerances of building frame and other adjacent construction.

C. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.05 INTERIOR ASSEMBLIES

A. General: Provide factory fabricated, factory finished framing members and doors with glazing and related anchorage and attachment devices.
   1. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Framing Cladding: Extruded aluminum.

2.06 GLAZING SYSTEMS

A. Glazing Infill, Glazing Gaskets, and Miscellaneous Glazing Accessories: Per Div. 08 Section "GLAZING."
   1. Provide framing system manufacturer's standard products, unless otherwise indicated.
   2. Glazing Tape and Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

B. Glazing Sealant: Per Div. 07 Section "JOINT SEALANTS;" compatible with adjacent materials; and recommended by framing system and sealant manufacturers for joint type and use condition.

2.07 HARDWARE

A. Entrance Door Hardware: As specified in Div. 08 Section "DOOR HARDWARE."
2.08 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   2. Sheet and Plate: ASTM B 209.
   3. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
   4. Finish: Galvanized or zinc-rich primed as specified in Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from Series 300 stainless steel.

E. Insulation: Mineral wool.

F. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

G. Framing Sealants: Manufacturer's standard sealants.

H. Joint Sealants: For installation at perimeter of framing, as specified in Div. 07 Section "JOINT SEALANTS."

I. Touch-Up Primer:
   1. For Primed Steel Components: Same material used for shop priming.
   2. For Galvanized Steel Components: Per Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

J. Finish Touch-Up Material: As recommended by coating manufacturer for field application.

K. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.09 FABRICATION

A. Field Measurements: Verify actual locations of structural supports for framing by field measurements before fabrication and indicate measurements on Shop Drawings.
B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Furnish framing factory-assembled where configurations and job site conditions permit.

E. Factory prepare and reinforce members as required to receive hardware.
   1. Entrance Door Frames: Reinforce framing members as required to support loads imposed by door operation and for installing entrance door hardware.
   2. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap frames for factory-installed entrance door hardware before applying finishes.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. High-Performance Organic Finish: AAMA 2604 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

2.11 STEEL FINISHES

A. High-Performance Organic Finish Where Visible: AAMA 621 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   2. Verify conditions are ready to receive work of this Section, field measurements are as indicated on approved shop drawings, and conditions conform to requirements of the manufacturer.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.
   1. Install units plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction.
   2. Securely and rigidly anchor units in place.
   3. Do not install damaged components.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
   1. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.

C. Provide alignment attachments and shims to permanently fasten system to building structure.
   1. Fit joints to produce hairline joints free of burrs and distortion.
   2. Rigidly secure nonmoving joints.
   3. Seal joints watertight unless otherwise indicated.

D. Set continuous sill members and flashing in full sealant bed as specified in Div. 07 Section "JOINT SEALANTS" to produce weathertight installation.

E. Pack mineral-fiber insulation in shim spaces at perimeter of exterior assemblies to maintain continuity of thermal barrier.

F. Install doors level and plumb, securely anchored, and without distortion.
   1. Install hardware indicated for field-installation per hardware manufacturers' written instructions using concealed fasteners when possible.
   2. Adjust weather-stripping contact and hardware movement for doors to produce proper operation.

G. Install glazing as specified in Div. 08 Section "GLAZING."
   1. Separate the glazing material perimeter from the perimeter framing system with approved fire-retardant glazing tape.
   2. Seal continuously around the glazing panel edge to the steel frame utilizing manufacturer's recommended sealant.

H. Install perimeter joint sealants as specified in Div. 07 Section "JOINT SEALANTS" to produce air-tight installation.

I. Framing Tolerances: Comply with the following non-accumulating maximum tolerances:
   1. Plumb: 1/8 inch in 12 feet; 1/4 inch over total length.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
   4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

J. Door Tolerances: Comply with the following non-accumulating maximum tolerances:
   2. Alignment: Plus or minus 1/16 inch from door face to face of framing.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Maximum Variation from Plumb: Plus or minus 1/16 inch, measured at jambs at floor.

K. Door Clearances:
1. Between Door and Frame: Maximum 1/8 inch.

3.03 REPAIR
A. Repairing Damaged Finishes: Immediately after installation, clean abraded and other areas where coatings are damaged.
1. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish per manufacturer's written instructions.

B. Replace components that cannot be repaired to Architect's and Owner's satisfaction.

3.04 ADJUSTING
A. Per Div. 01 Section "EXECUTION" and as follows:
1. Adjust operating door hardware to function smoothly as recommended by manufacturer.
2. For accessible entrances, adjust door closer speed per ADA standards.

3.05 CLEANING
A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
B. Aluminum Surfaces: Clean by washing thoroughly with clean water and soap and rinsing with clean water.

3.06 PROTECTION
A. Per Div. 01 Section "EXECUTION."
SECTION 08 43 13 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes conventionally glazed aluminum storefront assemblies.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
3. Div. 07 Section "JOINT SEALANTS" for installation of joint sealants installed with storefront and not specified in this Section.
4. Div. 08 Section "ALUMINUM DOORS" for entrance doors installed with storefront.
5. Div. 08 Section "GLAZED ALUMINUM CURTAIN WALLS."
6. Div. 08 Section "ALUMINUM WINDOWS" for operable windows installed in storefront.
7. Div. 08 Section "FIXED LOUVERS" for louvers installed in storefront.
8. Div. 08 Section "GLAZING" for glazing units installed in storefront.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
1. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
2. Coordinate the installation of power, signal, and control systems with installation of Facility Services utilities.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for storefronts.

B. Shop Drawings: For storefronts. Include plans, elevations, sections, details, and attachments to other work.
1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of storefronts, showing the following:
   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.
C. Samples: For each exposed finish color required for verification.

1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Welding certificates.
   2. NFRC-certified energy-performance certificates from manufacturer for storefronts, accessories, and components.

C. Delegated-design submittal per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."
   Include design data for storefronts for which design is assigned to Contractor.
   1. Detail fabrication and assembly of storefronts.

D. Test and Evaluation Reports:
   1. Product test reports for storefronts based on evaluation of comprehensive tests performed on manufacturer's standard assemblies by a qualified testing agency indicating compliance with performance requirements.

E. Sample warranties.

1.02 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure. Capable of fabricating storefronts that meet or exceed energy performance requirements indicated and of documenting said performance by certification, labeling, and inclusion in lists.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An authorized representative of manufacturer whose workers are trained and approved by manufacturer for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   3. Welder Qualifications: AWS certified within past 12 months for each type of weld required.
   4. Contractor's Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS"
   5. Design Professional Qualifications: Per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."

B. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Energy-Performance Certificates: For storefronts, accessories, and components, from manufacturer.
      a. Basis for Certification: NFRC-certified energy-performance values for each storefront assembly.
1.04 DELIVERY, STORAGE, AND HANDLING
   A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

1.05 FIELD CONDITIONS
   A. Ambient Conditions: Per Div. 01 Section "EXECUTION."

1.06 WARRANTY
   A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."
   B. Standard Warranty: Furnish manufacturer's standard 10 year warranty providing coverage against:
      1. Structural failures including, but not limited to, excessive deflection.
      2. Noise or vibration caused by wind, thermal, and structural movements.
      3. Water leakage through fixed glazing and framing areas.
      4. Thermal stresses and structural movements transferring to building structure or glazing.
      5. Glass breakage.
      6. Loosening or weakening of fasteners, attachments, and other components.
      7. Failure of framing and other internal sealants.
      8. Failure of operating units.
      9. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
   A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.
   B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS
   A. Manufacturers:
      1. EFCO Corporation.
      2. Kawneer/Traco; an Arconic, Inc. company.
      3. Oldcastle BuildingEnvelope
      4. Trulite Glass & Aluminum Solutions.
      5. Tubelite.
      8. YKK AP America Inc.
      9. Comparable products by other manufacturers will be considered.
2.03 DESCRIPTION

A. Storefront System: Factory fabricated and finished aluminum storefront system including framing members, glass infill, operable window infill, insulated metal panel infill, related flashings, sealant, and anchorage and attachment devices.
   1. Framing Style: Manufacturer's standard extruded-aluminum framing system as follows:
      a. Flush glazed without projecting stops; glazing retained mechanically with gaskets on four sides.
      b. Provide decorative extruded-aluminum trim profiles in sizes and configurations as indicated on Drawings.
   2. Framing Fabrication Method:
      a. Field-assembled stick system; outside glazed.
         1) Fabricate components for assembly using shear-block system.
   3. Framing Size:
      a. Vertical Mullion Dimensions: Manufacturer's standard 2 inches wide by 4-1/2 inches deep.
      b. Glazing Infill: Accommodate up to one inch thickness.
      c. Glazing Plane: Center.
   4. Framing Construction:

B. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies’ aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

2.04 PERFORMANCE / DESIGN CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design storefronts, using performance requirements and design criteria specified herein.

B. Performance, General: Comply with performance requirements specified, as determined by testing manufacturer's standard storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Performance: Design and size components to withstand the following load requirements without damage or permanent set:
   1. Design Wind Loads: As indicated on Drawings.
      a. Measure performance per ASTM E330 using test loads equal to 1.5 times design wind loads and not less than 10 second duration of maximum pressure.
      b. Deflection Normal to Wall Plane: For continuous aluminum structural members supporting edge of glass, total load deflection shall not exceed flexure limit of glass or L/175 of clear span for spans up to 13'-6" and to L/240 of clear span plus 1/4 inch for spans greater than 13'-6" and with full recovery of glazing materials. In any case, limit edge deflection of individual glazing lites to 3/4 inch.
      c. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which
reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
1) Operable Doors and Windows: Provide a Minimum 1/16-inch clearance between framing members and operable units.

2. Movement: Provide aluminum storefronts, including anchorage, that allow for the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, reduction of performance, and other detrimental effects
   a. Thermal Movements: Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      1) Expansion and contraction caused by 120 deg F ambient or 180 deg F material surface temperatures with interior ambient-air temperature of 75 deg F.
      2) Expansion and contraction caused by cycling temperature range of 170 deg F over a 12 hour period.
   b. Accommodate the following movement without damage to components or deterioration of seals:
      1) Movement of supporting structure.
      2) Deflection of structural support framing under permanent and dynamic loads.
      3) Verify allowable slab edge deflection with structural engineer (estimate at L/360).
      4) Mid-span slab edge deflection from uniformly distributed and concentrated live loads.

3. Accommodate dimensional tolerances of building frame and other adjacent construction.

D. Water Penetration: No water penetration through fixed glazing and framing areas when tested as follows:
   1. Test Pressure Differential: Not less than 6.24 lbf/sq. ft.
   3. Cyclic Static Air Pressure Test Method: ASTM E547 with minimum of 3 cycles, each lasting a minimum of 5 minutes.

E. Energy Performance: Certify and label energy performance for fixed glazing and framing areas per NFRC as follows:
   1. Thermal Transmittance (U-Factor): U-factor of not more than 0.45 Btu/sq. ft. x h x deg F per NFRC 100 or other nationally recognized accreditation organization standard acceptable to authorities having jurisdiction.
   2. Air Infiltration: Maximum air leakage through fixed framing and glass areas of 0.06 cfm/sq. ft. of fixed wall area as determined per ASTM E 283 at a static-air-pressure differential of 1.57 lbf/sq. ft.
   3. Solar Heat Gain Coefficient: SHGC of not more than 0.40 per NFRC 200.
   4. Condensation Resistance: Fixed glazing and framing areas shall have an condensation resistance rating of no less than 75 as determined according to AAMA 1503.

2.05 GLAZING SYSTEMS

A. Glazing Infill, Glazing Gaskets, and Miscellaneous Glazing Accessories: Per Div. 08 Section "GLAZING."
   1. Provide storefront manufacturer's standard products, unless otherwise indicated.
   2. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

B. Glazing Sealant: Per Div. 07 Section "JOINT SEALANTS;" compatible with adjacent materials; and recommended by manufacturer for joint type.
2.06 INFILL PANELS

A. Metal-Faced Infill Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
   1. Overall Panel Thickness: 1 inch.
   2. Exterior Skin: Aluminum.
      a. Thickness: Manufacturer's standard for finish and texture indicated.
      b. Finish: Matching storefront framing.
      c. Texture: Embossed.
      d. Backing Sheet: 1/8-inch-thick, tempered hardboard.
   3. Interior Skin: Aluminum.
      a. Thickness: Manufacturer's standard for finish and texture indicated.
      c. Texture: Embossed.
   4. Exterior Panel Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
   5. Surface-Burning Characteristics: For exposed interior surfaces of panels, when tested according to ASTM E 84 as follows:
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   6. Retention Clips: Manufacturer's standard one piece, formed from stainless steel or aluminum. Finish clips to match panels where visible.

2.07 OPERABLE DOOR AND WINDOW UNITS

A. Entrance Doors: Per Div. 08 Section "ALUMINUM DOORS."
   1. Provide manufacturer's standard replaceable compression weather stripping at fixed door stops.
      a. Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

B. Operable Venting Windows: Per Div. 08 Section "ALUMINUM WINDOWS."

2.08 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   2. Extruded Structural Pipe and Tubes: ASTM B 429.
   4. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
   4. Finish: Galvanized or zinc-rich primed as specified in Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from Series 300 stainless steel.

E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

F. Exposed Flashing: Aluminum sheet per Div. 07 Section "FLASHING AND SHEET METAL"; finish to match framing members.

G. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, ASTM A 240 of type recommended by manufacturer.

H. Framing Sealants: Manufacturer's standard sealants.

I. Joint Sealants: For installation at perimeter of storefronts, as specified in Div. 07 Section "JOINT SEALANTS."

J. Touch-Up Primer:
   1. For Primed Steel Components: Same material used for shop priming.
   2. For Galvanized Steel Components: Per Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

K. Finish Touch-Up Material: As recommended by coating manufacturer for field application.

L. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.09 FABRICATION

A. Field Measurements: Verify actual locations of structural supports for storefronts by field measurements before fabrication and indicate measurements on Shop Drawings.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   7. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Reinforce members as required to receive operable units.
   1. Entrance Door Frames: Reinforce storefront members as required to support loads imposed by door operation and for installing entrance door hardware.
2. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap frames for factory-installed entrance door hardware before applying finishes.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.
   1. Install components plumb and true in alignment with established lines and grades.
   2. Do not install damaged components.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
   1. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.

C. Provide alignment attachments and shims to permanently fasten system to building structure.
   1. Fit joints to produce hairline joints free of burrs and distortion.
   2. Rigidly secure nonmoving joints.
   3. Seal joints watertight unless otherwise indicated.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within storefronts to exterior.
   1. Install perimeter flashings. Turn up ends and edges of sill flashings and seal to form water tight dam; seal lap joints in flashings; seal flashings to adjacent work.

E. Set continuous sill members and flashing in full sealant bed as specified in Div. 07 Section "JOINT SEALANTS" to produce weathertight installation.

F. Pack mineral-fiber insulation in shim spaces at perimeter of exterior assemblies to maintain continuity of thermal barrier.

G. Install operable units and louvers level and plumb, securely anchored, and without distortion.
1. Adjust weather-stripping contact and hardware movement for operable doors and windows to produce proper operation.
2. Fit blank-off plates behind louvers tight to ductwork.

H. Install glazing as specified in Div. 08 Section "GLAZING."
   1. Install using exterior gasket glazing (dry) method.

I. Install insulated metal panel infill in manner similar to pressure-glazing, unless otherwise indicated.

J. Install perimeter joint sealants as specified in Div. 07 Section "JOINT SEALANTS" to produce weathertight installation.

K. Erection Tolerances: Comply with the following non-accumulating maximum tolerances:
   1. Plumb: 1/8 inch in 12 feet; 1/4 inch over total length.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
   4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.03 "QUALITY REQUIREMENTS"CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES"

3.04 PROTECTION

A. Per Div. 01 Section "EXECUTION."

END OF SECTION 08 43 13
SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes conventionally glazed aluminum curtain-wall assemblies.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Section "JOINT SEALANTS" for installation of joint sealants installed with curtain walls and not specified in this Section.
   4. Div. 08 Section "ALUMINUM ENTRANCES" for entrance doors installed in curtain wall.
   5. Div. 08 Section "ALUMINUM WINDOWS" for operable windows installed in curtain wall.
   6. Div. 08 Section "FIXED LOUVERS" for louvers installed in curtain walls.
   7. Div. 08 Section "GLAZING" for glazing units installed in curtain walls.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each vertical-to-horizontal intersection of curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.

C. Finish Samples: For each exposed finish color required for verification.

1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Welding certificates.
2. NFRC-certified energy-performance certificates from manufacturer for curtain walls, accessories, and components.

B. Delegated-design submittal per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."
   Include design data for curtain walls for which design is assigned to Contractor.
   1. Detail fabrication and assembly of glazed-aluminum curtain walls.

C. Test and Evaluation Reports: As follows:
   1. Product test reports for curtain walls based on evaluation of comprehensive tests performed on manufacturer's standard assemblies by a qualified testing agency indicating compliance with performance requirements.

C. Sample warranties.

1.02 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure. Capable of fabricating curtain walls that meet or exceed energy performance requirements indicated and of documenting said performance by certification, labeling, and inclusion in lists.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An authorized representative of manufacturer whose workers are trained and approved by manufacturer for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   3. Welder Qualifications: AWS certified within past 12 months for each type of weld required.
   4. Contractor's Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS"
   5. Design Professional Qualifications: Per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."

B. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Energy-Performance Certificates: For curtain walls, accessories, and components, from manufacturer.
      a. Basis for Certification: NFRC-certified energy-performance values for each curtain wall assembly.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
1.05 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION."

1.06 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard 10 year warranty providing coverage against:
   1. Structural failures including, but not limited to, excessive deflection.
   2. Noise or vibration created by wind and thermal and structural movements.
   3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   4. Water penetration through fixed glazing and framing areas.
   5. Failure also includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glass breakage.
      e. Noise or vibration created by wind, thermal, and structural movements.
      f. Loosening or weakening of fasteners, attachments, and other components.
      g. Failure of framing and other internal sealants.
      h. Failure of operating units.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. EFCO Corporation.
   2. Kawneer/Traco; an Arconic, Inc. company.
   3. Oldcastle BuildingEnvelope
   4. Trulite Glass & Aluminum Solutions.
   5. Tubelite.
   8. YKK AP America Inc.
   9. Comparable products by other manufacturers will be considered.
2.03 DESCRIPTION

A. Curtain Wall System: Factory fabricated and finished aluminum curtainwall system including framing members, glass infill, related flashings, sealant, anchorage and attachment devices.
   1. Style: Manufacturer's standard extruded-aluminum framing system as follows:
      a. Pressure-glazed with pressure-plate and mullion covers on four sides.
   2. Framing Fabrication Method:
      a. Field-assembled stick system; outside glazed.
         1) Fabricate components for assembly using shear-block system.
   3. Framing Size:
      a. Vertical Mullion Face Width: 2-1/2 inches.
      b. Vertical Mullion Depth including Glazing Recess and Mullion Caps: 6 inches.
      c. Vertical Mullion Cover Depth and Profile: 3/4 inch rectangular.
      d. Horizontal Mullion Cover Depth and Profile: 3/4 inch rectangular.
      e. Glazing Infill: Accommodate up to one inch thickness.
   4. Framing Construction:

B. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

2.04 PERFORMANCE CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design curtain walls, using performance requirements and design criteria specified herein.

B. Performance, General: Comply with performance requirements specified, as determined by testing manufacturer's standard curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Performance: Design and size components to withstand the following load requirements without damage or permanent set:
   1. Design Wind Loads: As indicated on Drawings.
      a. Measure performance per ASTM E330 using test loads equal to 1.5 times design wind loads and not less than 10 second duration of maximum pressure.
      b. Deflection Normal to Wall Plane: For continuous aluminum structural members supporting edge of glass, total load deflection shall not exceed flexure limit of glass or L/175 of clear span for spans up to 13'-6" and to L/240 of clear span plus 1/4 inch for spans greater than 13'-6" and with full recovery of glazing materials. In any case, limit edge deflection of individual glazing lites to 3/4 inch.
      c. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
1) Operable Door and Window Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

2. Movement: Accommodate the following movement without damage to components or deterioration of seals:
   a. Thermal Movements: Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      1) Expansion and contraction caused by 120 deg F ambient or 180 deg F material surface temperatures with interior ambient-air temperature of 75 deg F.
      2) Expansion and contraction caused by cycling temperature range of 170 deg F over a 12 hour period.
   b. Movement of supporting structure.
   c. Deflection of structural support framing under permanent and dynamic loads.
   d. Mid-span slab edge deflection from uniformly distributed and concentrated live loads.

3. Accommodate dimensional tolerances of building frame and other adjacent construction.

D. Water Penetration: No water penetration through fixed glazing and framing areas when tested as follows:
   3. Cyclic Static Air Pressure Test Method: ASTM E547 with minimum of 3 cycles, each lasting a minimum of 5 minutes.

E. Energy Performance: Certify and label energy performance for fixed glazing and framing areas per NFRC as follows:
   1. Thermal Transmittance (U-Factor): U-factor of not more than 0.45 Btu/sq. ft. x h x deg F per NFRC 100.
   2. Air Infiltration: Maximum air leakage through fixed framing and glass areas of 0.06 cfm/sq. ft. of fixed wall area as determined per ASTM E 283 at a static-air-pressure differential of 1.57 lbf/sq. ft.
   3. Solar Heat Gain Coefficient: SHGC of not more than 0.40 per NFRC 200.
   4. Condensation Resistance: Fixed glazing and framing areas shall have an condensation resistance rating of no less than 75 as determined according to AAMA 1503.

2.05 GLAZING

A. Glazing Infill, Glazing Gaskets, and Miscellaneous Glazing Accessories: Per Div. 08 Section “GLAZING.”
   1. Provide curtain wall manufacturer’s standard products, unless otherwise indicated.
   2. For standard dry glazing systems, provide sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets.

B. Glazing Sealant: Per Div. 07 Section "JOINT SEALANTS;" compatible with adjacent materials; and recommended by manufacturer for joint type.

2.06 INFILL PANELS

A. Metal-Faced Infill Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
   1. Overall Panel Thickness: 1 inch.
   2. Exterior Skin: Aluminum.
      a. Thickness: Manufacturer’s standard for finish and texture indicated.
      b. Finish: Matching storefront framing.
      c. Texture: Embossed.
d. Backing Sheet: 1/8-inch thick, tempered hardboard.

3. Interior Skin: Aluminum.
   a. Thickness: Manufacturer's standard for finish and texture indicated.
   c. Texture: Embossed.

4. Exterior Panel/Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.

5. Surface-Burning Characteristics: For exposed interior surfaces of panels, when tested according to ASTM E 84 as follows:
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.

6. Retention Clips: Manufacturer's standard one piece, formed from stainless steel or aluminum. Finish clips to match panels where visible.

2.07 OPERABLE DOOR AND WINDOW UNITS

A. Entrance Doors: Per Div. 08 Section "ALUMINUM DOORS."
   1. Provide manufacturer's standard replaceable compression weather stripping at fixed door stops.
      a. Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

B. Operable Venting Windows: Per Div. 08 Section "ALUMINUM WINDOWS."

2.08 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   4. Structural Profiles: ASTM B 308/B 308M.
   5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
   4. Finish: Galvanized or zinc-rich primed as specified in Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from Series 300 stainless steel.

E. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch, that accommodate fabrication and installation tolerances in material and finish and are compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

F. Exposed Flashing: Aluminum sheet per Div. 07 Section "FLASHING AND SHEET METAL"; finish to match framing members.

G. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, ASTM A 240 of type recommended by manufacturer.

H. Framing Sealants: Manufacturer's standard sealants.

I. Joint Sealants: For installation at perimeter of curtain walls, as specified in Div. 07 Section "JOINT SEALANTS."

J. Touch-Up Primer:
   1. For Primed Steel Components: Same material used for shop priming.
   2. For Galvanized Steel Components: Per Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

K. Finish Touch-Up Material: As recommended by coating manufacturer for field application.

L. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.09 FABRICATION

A. Field Measurements: Verify actual locations of structural supports for curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   7. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
   8. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of curtain wall and secondary seal weeped and vented to exterior.

D. Reinforce members as required to receive operable units.
   1. Entrance Door Frames: Reinforce curtain wall members as required to support loads imposed by door operation and for installing entrance door hardware.
   2. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap frames for factory-installed entrance door hardware before applying finishes.
E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.
   1. Install components plumb and true in alignment with established lines and grades.
   2. Do not install damaged components.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
   1. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   2. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

C. Provide alignment attachments and shims to permanently fasten system to building structure.
   1. Fit joints to produce hairline joints free of burrs and distortion.
   2. Rigidly secure nonmoving joints.
   3. Seal joints watertight unless otherwise indicated.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within curtain walls to exterior.
   1. Install perimeter flashings. Turn up ends and edges of sill flashings and seal to form water tight dam; seal lap joints in flashings; seal flashings to adjacent work.

E. Pack mineral-fiber insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Install operable units and louvers level and plumb, securely anchored, and without distortion.
   1. Adjust weather-stripping contact and hardware movement for operable doors and windows to produce proper operation.
   2. Fit blank-off plates behind louvers tight to ductwork.

G. Install glazing per Div. 08 Section "GLAZING."
1. Install pressure-glazed systems using exterior gasket glazing (dry) method.

H. Install insulated metal panel infill in manner similar to pressure-glazing, unless otherwise indicated.

I. Install perimeter joint sealants as specified in Div. 07 Section "JOINT SEALANTS" to produce weathertight installation.

J. Erection Tolerances: Comply with the following non-accumulating maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
      c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
   4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.03 "QUALITY REQUIREMENTS" CLEANING

   A. Per Div. 01 Sections "CLOSEOUT PROCEDURES"

3.04 PROTECTION

   A. Per Div. 01 Section "EXECUTION."

END OF SECTION 08 44 13
SECTION 08 51 13 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes aluminum windows for exterior locations.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 08 Section "ALUMINUM-FRAMED STOREFRONTS" for coordinating finish among aluminum fenestration units.
   4. Div. 08 Section "GLAZED ALUMINUM CURTAIN WALLS" for coordinating finish among aluminum fenestration units.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   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 and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
   3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchorage, flashing, sealing perimeters, and protecting finishes.
   4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
   5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include glazing and fabrication methods.

B. Shop Drawings: Include accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each type and color of exposed finish for verification.
   1. Sample Size: Manufacturer's standard.
   2. Include samples of hardware and accessories involving finish selection.

D. Product schedule for aluminum windows. Use same designations indicated on Drawings.
1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's signed and dated certificates indicating the U-factor, SHGC, VT, and air leakage rate for each window product.

B. Test and Evaluation Reports: As follows:
   1. Product test reports for each type of aluminum windows.

C. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

B. Operation and Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

C. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.03 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A firm acceptable to manufacturer for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.

1.04 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard warranty providing coverage against failures in materials or workmanship as follows:
   1. Failures include, but are not limited to, the following:
      a. Failure to meet performance requirements.
      b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
      c. Faulty operation of movable sash and hardware.
      d. Deterioration of materials and finishes beyond normal weathering.
      e. Failure of insulating glass.
   2. Warranty Period:
      a. Window: 10 years from date of Substantial Completion.
      b. Glazing Units: 10 years from date of Substantial Completion.

C. Special Finish Warranty: Per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. EFCO Corporation.
   2. Kawneer/Traco; an Arconic, Inc. company.
   3. Oldcastle BuildingEnvelope
   5. Wausau Window and Wall Systems.
   7. YKK AP America Inc.
   8. Comparable products by other manufacturers will be considered.

2.03 DESCRIPTION

A. Aluminum Windows: Factory fabricated, factory-glazed, factory finished, with operating hardware, glass infill, insect screens, related flashings, sealant, and anchorage and attachment devices of the following operating types in locations as indicated on Drawings:
   1. C = Casement window; project out.
   2. FW = Fixed window.

B. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

2.04 PERFORMANCE CRITERIA

A. Performance, General: Comply with performance requirements specified, as determined by testing manufacturer's standard windows representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Structural Performance Requirements: Aluminum windows shall conform to Class CW-PG-30 requirements for window operating types indicated of the voluntary specifications in AAMA/WDMA/CSA 101/I.S.2/A440-17, be labeled with the AAMA or WDMA label, have the sash arrangements, and be of the sizes indicated on the Drawings.

C. Thermal Performance Requirements:
   1. Movement: Provide aluminum windows that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by
preventing buckling, opening of joints, overstressing of components, failure of joint
sealants, failure of connections, reduction of performance, and other detrimental effects.  
Base engineering calculation on surface temperatures of materials due to both solar heat
gain and nighttime-sky heat loss.
   a. Thermal Movements: Base engineering calculations on surface temperatures of
   materials due to both solar heat gain and nighttime-sky heat loss.
   1) Expansion and contraction caused by 120 deg F ambient or 180 deg F
   material surface temperatures with interior ambient-air temperature of 75
deg F.
   2) Expansion and contraction caused by cycling temperature range of 170
deg F over a 12 hour period.

D. Water Penetration: No water penetration through fixed glazing and framing areas when tested
as follows:
2.  Cyclic Static Air Pressure Test Method: ASTM E547 with minimum of 2 cycles, each
    lasting a minimum of 5 minutes.
3.  Test Pressure Differential: Per the AAMA/WDMA/CSA 101/I.S.2/A440 performance class
    indicated.

E. Energy Performance: Certify and label energy performance for fixed glazing and framing areas
per NFRC 400 as follows:
1.  Thermal Transmittance (U-Factor): U-factor of not more than the following in Btu/sq. ft.
    x h x deg F per NFRC 100.
   a.  Metal framing, operable: 0.45
   b.  Metal framing, fixed: 0.36
2.  Air Infiltration: Maximum air leakage through fixed framing and glass areas of 0.20
    cfm/sq. ft. of fixed wall area per NFRC 400.
3.  Solar Heat Gain Coefficient: SHGC of not more than the following per NFRC 200.
   a.  Metal framing, operable: 0.33
   b.  Metal framing, fixed: 0.38
4.  Visible Transmission (VT/SHGC): Not more than 1.10 per NFRC 200 or other nationally
    recognized accreditation organization standard acceptable to authorities having
    jurisdiction.

F. Condensation-Resistance (CR): Provide aluminum windows with a minimum CR determined
according to NFRC 500 of 45.

G. Acoustical Performance Requirements: Provide aluminum windows identical to those tested by
a qualified testing agency for the following acoustical properties per test methods indicated:
1.  Sound-Transmission Requirements: Tested for laboratory sound-transmission loss
    performance per ASTM E90, determined per ASTM E413, and rated for not less than 30
    STC.
2.  Outside-Inside Transmission Class (OITC): Tested for laboratory sound-transmission loss
    performance per ASTM E90, determined per ASTM E1332, and rated for not less than 26
    OITC.

2.05 COMPONENTS


B. Mullions and Cover Plates: Thermally broken, extruded-aluminum, matching window units,
sized to join adjacent window units and seal against moisture intrusion.
1. Provide units complying with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated for adjacent window unit, complete with anchors for support to structure and installation of window units.

2. Provide integral reinforcement of shaped steel structural section as required to withstand design wind loads.

3. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated.

C. Exterior Sill Extensions: Extruded-aluminum profiles in sizes and configurations indicated shaped to engage concealed, continuous, extruded-aluminum cleats.

D. Exterior Trim: Extruded-aluminum profiles in sizes and configurations indicated.

E. Interior Trim: Extruded-aluminum, two-piece, snap-together, profiles in sizes and configurations indicated.

2.06 GLAZING SYSTEMS

A. Glazing Infill, Glazing Gaskets, and Miscellaneous Glazing Accessories: Per Div. 08 Section "GLAZING."

1. Provide window manufacturer's standard products, unless otherwise indicated.

2.07 HARDWARE

A. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, bronze, or carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.
   a. Aluminum: Match framing or BHMA 628 satin chrome.
   b. Bronze: Match BHMA 626 satin chrome.
   c. Stainless Steel: Match BHMA 630 satin.
   d. Steel: Match BHMA 652 satin chrome.

2. Concealed Hardware: As standard with window manufacturer.

B. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.
   a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.

2. Multi-Bar Hinges: Complying with AAMA 904; non-friction type, not less than two per sash.

3. Lock: Lever handle and cam-action lock with keeper.

2.08 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: Full, inside for project-outFull, outside for double-hung sashes.

B. Aluminum Frames: Manufacturer's standard extruded-aluminum or formed-tubular-aluminum members complying with SMA 1004 or SMA 1201. Fabricate with mitered or coped joints,
concealed fasteners, adjustable rollers, and removable PVC or PE spline/anchor concealing edge of mesh.
1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
2. Finish: Baked-on organic coating in color to match window frame.

C. Glass-Fiber Mesh Fabric: 18 x16 or 18 x 14 mesh of 0.011 inch diameter PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656.
1. Mesh Color: Charcoal gray.

2.09 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extruded Profiles: ASTM B 221.
2. Sheet and Plate: ASTM B 209.
3. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
4. Finish: Galvanized or zinc-rich primed as specified in Div. 05 Section "SHOP-APPLIED GALVANIC COATINGS FOR METAL."

C. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

D. Exposed Flashing: Aluminum sheet per Div. 07 Section "FLASHING AND SHEET METAL"; finish to match window frame members.

E. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, ASTM A 240 of type recommended by manufacturer.

F. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning window components.

G. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with window members, trim, hardware, anchors, other components, and adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Exposed Fasteners: Avoid using exposed fasteners to the greatest extent possible. Where unavoidable, use exposed fasteners fabricated from Series 300 stainless steel with countersunk Phillips screw heads.
   a. For fastening through window members, use fasteners that match finish of framing.
   b. For application of hardware, use fasteners that match finish of hardware being fastened.

H. Framing Sealants: Manufacturer's standard sealants. At sills, subsills, sill flashing, sill receptors, sill-to-jamb joints, sill fastener penetrations, and similar conditions, provide ASTM C920 Use I (immersible) sealant suitable for immersion service per ASTM C 1247.

I. Joint Sealants: For installation at perimeter of window units, as specified in Div. 07 Section "JOINT SEALANTS."
J. Finish Touch-Up Material: As recommended by coating manufacturer for field application.

K. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.10 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Thermally Improved Construction: Fabricate frames and sashes with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

C. Glaze aluminum windows in the factory as specified in Div. 08 Section "GLAZING".

D. Provide water-shed members above lines of natural water penetration.

E. Weather strip each operable sash to provide weathertight installation.

F. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.11 ALUMINUM FINISHES

A. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
   2. Examine wall flashings, weather barriers, and other built-in components to ensure weathertight window installation.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112-18.
   1. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement.
   2. Anchor windows securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

B. Install windows and components to drain water passing joints, condensation occurring within framing members, and moisture migrating within windows to the exterior.

C. Set continuous sill members and flashing in full sealant bed as specified in Div. 07 Section "JOINT SEALANTS" to produce weathertight installation.
   1. At joints in extruded subsills, and similar water-shedding components, install underlying flashing, formed and sealed to drain water passing joints to the exterior and prevent water infiltrating to interior.
   2. Overlap and seal metal flashing joints with butyl sealant.
   3. Seal concealed fastener penetrations with butyl sealant.

3.03 "QUALITY REQUIREMENTS"ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
   1. Keep protective films and coverings in place until final cleaning.

C. Aluminum Surfaces: Clean by washing thoroughly with clean water and soap and rinsing with clean water.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.05 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08 51 13
SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hardware for swinging doors.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 WORK INCLUDED

A. Furnish all items of Finish Hardware specified, scheduled, shown or required herein except those items specifically excluded from this section of the specification.

   Related work:
   1. Div. 06 Section "Miscellaneous Rough Carpentry."
   2. Div. 06 Section "Finish Carpentry: Installation of Finish Hardware."
   3. Div. 08 Section "Hollow Metal Doors and Frames."
   4. Div. 08 Section "Aluminum Doors."
   5. Div. 08 Section "Flush Wood Door."
   6. Div. 08 Section "Fire-Rated Glazed Framing and Door Assemblies."
   7. Div. 08 Section "Aluminum Framed Storefronts."
   8. Div. 28 Section "Digital, Addressable Fire-Alarm System."

B. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:
   1. Cabinet Hardware.
      Signs, except as noted.
      Overhead and Coiling doors

1.03 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
   Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
   Provide hardware for fire-rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

   Hardware Supplier:
   Shall be an established firm dealing in contract builders' hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the pro-
ject. The distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant (AHC).

Electrified Door Hardware Supplier:
Shall be an experienced door hardware supplier who has completed projects with electrified door hardware 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, and who is acceptable to manufacturer of primary materials.
Shall prepare data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer’s standard units in assemblies similar to those indicated for this project.
Shall have experience in providing consulting services for electrified door hardware installations.

Pre-installation Meeting:
1. Before hardware installation, General Contractor/Construction Manager will request a hardware installation meeting be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall conduct the meeting. Meeting to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Meeting to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
When any electrical or pneumatic hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.
Convene one week or more prior to commencing work of this Section.
The Hardware Supplier shall include the cost of this meeting in his proposal.

Manufacturer:
2. Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.

1.04 SUBMITTALS:

Hardware Schedule
1. Submit number of Hardware Schedules as directed in Division 1.
Follow guidelines established in Door & Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule unless noted otherwise.
Schedule will include the following:
a. Door Index including opening numbers and the assigned Finish Hardware set.
b. Preface sheet listing category only and manufacturer's names of items being furnished as follows:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIFIED</th>
<th>SCHEDULED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinges</td>
<td>Manufacturer A</td>
<td>Manufacturer B</td>
</tr>
<tr>
<td>Lock sets</td>
<td>Manufacturer X</td>
<td>Manufacturer X</td>
</tr>
<tr>
<td>Kick Plates</td>
<td>Open</td>
<td>Manufacturer Z</td>
</tr>
</tbody>
</table>

c. Hardware Locations: Refer to Article 3.1 B.2 Locations.
d. Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
e. Hardware Description: Quantity, category, product number, fasteners, and finish.
f. Headings that refer to the specified Hardware Set Numbers.
g. Scheduling Sequence shown in Hardware Sets.
h. Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.
i. Electrified Hardware system operation description.
j. "Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."
k. Typed Copy.
l. Double-Spacing.
m. 8-1/2 x 11 inch sheets
n. U.S. Standard Finish symbols or BHMA Finish symbols.

Product Data:
2. Submit, in booklet form Manufacturers Catalog cut sheets of scheduled hardware. Submit product data with hardware schedule.

Samples:
Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample, if required, of each type of exposed hardware unit, finished as required and tagged with full description for coordination with schedule.
3. Samples will be returned to the supplier. Units, which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

Key Schedule:
4. All keying of cylinders and cores will be provided by the Owner.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING:

Label each item of hardware with the appropriate door number and Hardware Schedule heading number and deliver to the installer so designated by the contractor.

WARRANTIES:

Refer to Division 1 for warranty requirements.

During the warranty period, replace defective work, including labor, materials and other costs incidental to the work. Replace work found to be defective as defined in the General Conditions.

PRODUCT

FURNISH EACH CATEGORY WITH THE PRODUCTS OF ONLY ONE MANUFACTURER UNLESS SPECIFIED OTHERWISE; THIS REQUIREMENT IS MANDATORY WHETHER VARIOUS MANUFACTURERS ARE LISTED OR NOT.

PROVIDE THE PRODUCTS OF MANUFACTURER DESIGNATED OR IF MORE THAN ONE MANUFACTURER IS LISTED, THE COMPARABLE PRODUCT OF ONE OF THE OTHER MANUFACTURERS LISTED. WHERE ONLY ONE MANUFACTURER OR PRODUCT IS LISTED, IT IS UNDERSTOOD THAT THIS IS THE OWNER’S BUILDING STANDARD AND "NO SUBSTITUTION" IS ALLOWED.

A. Hinges & Continuous Hinges:
1. Furnish hinges of class and size as listed in sets.
Numbers used are Ives (IVE). Products of a BHMA member are acceptable.

Locksets and Latchsets - Mortise Type:

Locks are to have a standard 2 ¾” backset. Deadbolt shall be a full 1” throw, constructed of stainless steel. Function numbers listed in sets are Schlage (SCH) L9000 with 03N lever trim. (No substitutions per owner standards) Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8” beyond door frame trim at single doors and have 7/8” lip to center at pairs of 1-3/4” doors.

B. Removable Mullions
1. Interior hollow metal or wood, mullion is removable only with use of building keys.
   a. Von Duprin (VON) KR4954/KR9954 Series
2. Exterior hollow metal, mullion is removable only with the use of building keys.
   a. Von Duprin (VON) KR4954 Series
3. Exterior aluminum or FRP, mullion is removable only with use of building keys.
   a. Special-Lite (SPE) SL-60-KR

C. Door Pulls:
1. Vandal Resistant Type:
   a. Function numbers listed in sets are Ives (IVE) VR Series.
2. Recessed Flush Pull Type:
   a. Furnished by the door manufacturer where specified in sets.

D. Door Trim:
1. Push Plates: Ives (IVE) 8200 Series
   a. Equal products of any BHMA manufacturer

E. Flush Bolts:
1. Furnish manual and automatic type as listed in sets.
2. Numbers used are Ives (IVE) FB Series.
   a. Equal products of any BHMA manufacturer

Exit Devices
3. All exit devices shall meet ANSI A156.3, 1994, Grade 1 test standards. Devices shall be push through type with touch pad design. Center Case: Shall be interchangeable with all functions. Trim: Shall be heavy-duty type. Function numbers listed in sets are Von Duprin (VON) 98 series. (No substitutions per owner standards)
4. Trim:
   a. As specified in sets.
   b. Levers to match lockset design where specified.

Closers:
5. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule. Products listed in sets are LCN 4040XP Series. (No substitutions per owner standards)

F. Low Energy Door Operators:
1. Products listed in sets are LCN 4642 and Besam SW200i series.
   a. Supply as specified in set, no substitutions.

Overhead Holders and Stops:
Type, function and fasteners must be the same as Glynn-Johnson specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
Type, function, and fasteners must be the same as Glynn-Johnson specified. Size per manufacturer's selector chart.
   b. IR-Glynn-Johnson
   c. Equal products of any BHMA manufacturer

Protection Plates:
Furnish .050 inches thick 10" high x door width less 2" at single doors and less 1" at pairs. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less 2".
Any BHMA manufacturing product meeting above is acceptable.

G. Wall Stops:
1. Length to exceed projection of all other hardware. Provide with threaded studs and expansion shields for masonry wall construction. Install with slope at top.
   a. IR-Ives WS33
   b. BHMA L12011 or L12021

Thresholds:
1/2" high - 5" wide. Cope at jambs.
Furnish full wall opening width when frames are recessed.
Cope in front of mullions if thresholds project beyond door faces.
Furnish with non-ferrous Stainless-Steel Screws and Lead Anchors.
Install fasteners per installation instructions and secure tightly for proper alignment with top of threshold.
All thresholds shall be properly sealed with Vulkem or industry equivalent caulk and set in a full bed of mastic.
   National Guard as listed in sets
   Equal of Zero or Reese

Door Sweeps:
   Surface Sweeps:
   National Guard as listed in sets
   Equal by Zero or Reese

Weather-stripping:
   Apply to head and jamb stops.
   Solid Bar stock all sides
   National Guard as listed in sets
   c. Equal by Zero or Reese

Fire and Smoke Seals:
Perimeter Seals:
   National Guard (listed in sets)
   Zero
H. Electric Power Transfers:
   Transfer power from door frame to edge of door
   Products listed in sets are Von Duprin (VON) EPT-10. (No substitutions per owner standards)

I. Power Supplies:
   1. Furnish Von Duprin (VON) PS Series power supplies as required in hardware sets. (No substitutions per owner standards)

J. Door Position Switches:
   1. George Risk Industries (GRI) 180-12 Series furnished by the owner.
   2. Provide factory prep for doors and frames as required.

Miscellaneous:
   Furnish items not categorized in the above descriptions but specified by manufacturer’s names in Hardware Sets.

Fasteners:
   Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.
   3. Screw bolts will not be permitted on reinforced metal doors or wood doors where blocking is specified.

1.06 FINISHES:

A. Generally, Dull Chrome, US26D / BHMA 626. Provide finish for each item as indicated in sets.

TEMPLATES AND HARDWARE LOCATION:

Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.

Furnish metal template to frame/door supplier for continuous hinge.

Refer to Article 3.1 B.2, Locations, and coordinate with templates.

CYLINDERS AND KEYING:

All hardware components capable of being locked shall be provided with a mortise or rim type cylinder as required by the function of the locking device. Provide the proper cam or tailpiece as required.
   1. Furnish Best E Series cylinders to accept Best 7-pin small format interchangeable cores.
   2. Cams/ tail piece shall be riveted, not screw-in type.

Permanent cores shall be Best 7-pin SFIC cores furnished by the Owner.

Furnish temporary keyed construction cores as listed below.
PART 2 - EXECUTION

2.01 INSTALLATION

General:
Install hardware according to manufacturer’s installations and template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.

1. Provide blocking/reinforcement for all wall mounted Hardware.
2. Reinforced hollow metal doors and frames and reinforced aluminum door and frames will be drilled and tapped for machine screws.
4. Install weather-strip gasket prior to parallel arm closer bracket, rim exit device or any stop mounted hardware. Gasket to provide a continuous seal around perimeter of door opening. Allow for gasket when installing finish hardware. Door closers will require special templating. Exit devices will require adjustment in backset.

B. Existing Frame Modification:

1. Modify, patch and repair all existing frames as required for new door and hardware items specified. This supplier will conduct inspections for the following existing conditions:
2. Field verify existing hinge size, weight and location for new doors. Field verify existing strike locations. Furnish custom strikes as required for frames prepped with non-standard strikes.
3. All repairs and modifications (where applicable) shall be in compliance with NFPA 80.

C. Locations:

Dimensions are from finish floor to center line of items.
1. Include this list in Hardware Schedule.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DIMENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinges</td>
<td>Door Manufacturer’s Standard</td>
</tr>
<tr>
<td>Levers</td>
<td>Door Manufacturer’s Standard</td>
</tr>
<tr>
<td>Exit Device Touchbar</td>
<td>Per Template</td>
</tr>
<tr>
<td>Wall Stops/holders</td>
<td>At Head</td>
</tr>
</tbody>
</table>

Final Adjustment:
Provide the services of a representative to inspect material furnished and its installation and adjustment, to make final hardware adjustment, and to instruct the Owner’s personnel in adjustment, care and maintenance of hardware.

2. Locksets, closers and exit devices shall be inspected by the factory representative and adjusted after installation and after the HVAC system is in operation, to insure correct installation and proper adjustment in operation. The manufacturer’s representative shall prepare a written report stating compliance, and also recording locations and kinds of noncompliance. The original report shall be forwarded to the Architect with copies to the Contractor, hardware installer and building owner.

D. Technical and Warranty Information:
1. At the completion of the project, the technical and warranty information coalesced and kept on file by the General Contractor/Construction Manager shall be given to the Owner or Owner’s Agent. In addition to both the technical and warranty information, all factory order acknowledgement numbers supplied to the General Contractor/Construction Manager during the construction period shall be given to the Owner or Owner’s Agent. The warranty information and factory order acknowledgement numbers shall serve to both expedite and properly execute any warranty work that may be required on the various hardware items supplied on the project.

2. Submit to General Contractor/Construction Manager, two copies each of parts and service manuals and two each of any special installation or adjustment tools. Include for locksets, exit devices, door closers and any electrical products.

2.02 HARDWARE SETS:

HW SET: 01

1 EA CONTINUOUS HINGE 224HD 628 IVE
1 EA FIRE EXIT HARDWARE W/IND. 98L-F 996L-2SI 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RIM CYLINDER T-TURN XB13-379 626 SCH
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA KICK PLATE 8400 10” X 2” LDW B-CS 630 IVE
1 SET SEALS 2525B BRN NGP

NOTE: WHEN UNLOCKED, THE OUTSIDE LEVER CAN BE LOCKED WITH THE INSIDE THUMB TURN. THE VISUAL INDICATOR LOCATED ON THE INSIDE WILL DISPLAY THE LOCKING STATUS.

HW SET: 02

1 EA CONTINUOUS HINGE 112HD-EPT 628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DOOR SWEEP C627A CL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 03.
HW SET: 03

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS904-4RL-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630 LCN
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS904-4RL-4RL WILL ALSO SUPPLY POWER FOR DOOR(S) ASSIGNED TO HARDWARE SET 02. PRIOR TO FURNISHING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

HW SET: 04

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 05.
HW SET: 05

1 EA CONTINUOUS HINGE  112HD-EPT628 IVE
1 EA POWER TRANSFER   EPT-10  689 VON
1 EA ELR PANIC HARDWARE  QEL98NL-OP  626 VON
1 EA RIM CYLINDER 12E72  626 BES
1 EA RECESSED FLUSH PULL  BY DOOR MANUFACTURER  628 B/O
1 EA AUTO-EQUALIZER  4642 REGARM  689 LCN
1 EA OVERHEAD STOP  9005  630 GLY
1 EA POWER SUPPLY PS904-4RL-4RL  GRY VON
1 EA ELECTRICAL DRAWING  RISER DIAGRAM  VON
2 EA ACTUATOR, WALL MOUNT  8310-856T  LCN
2 EA ESCUTCHEON 8310-874  630 LCN
1 EA CARD READER  BY SECURITY CONTRACTOR  B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR  B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR  B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

NOTE: THE PS904-4RL-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 04. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

HW SET: 06

1 EA CONTINUOUS HINGE  112HD-EPT628 IVE
1 EA POWER TRANSFER   EPT-10  689 VON
1 EA EU STOREROOM LOCK  L9092LEU 03N  24VDC  626 SCH
1 EA MORTISE CYLINDER  1E74  626 BES
1 EA SURFACE CLOSER  4040XP SCUSH  689 LCN
1 EA POWER SUPPLY PS902  GRY VON
1 EA CARD READER  BY SECURITY CONTRACTOR  B/O
1 EA INTERCOM W/RELEASE  BY SECURITY CONTRACTOR  B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR  B/O

OPERATION: THE CARD READER OR THE REMOTE RELEASE WILL UNLOCK THE DOOR FOR ENTRY. THE INSIDE LEVER WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

HW SET: 07

1 EA CONTINUOUS HINGE  224HD-EPT628 IVE
1 EA POWER TRANSFER   EPT-10  689 VON
1 EA EU STOREROOM LOCK  L9092LEU 03N  24VDC  626 SCH
1 EA MORTISE CYLINDER  1E74  626 BES
1 EA SURFACE CLOSER  4040XP SCUSH  689 LCN
1 EA KICK PLATE  8400 10" X 2" LDW B-CS  630 IVE

08 71 00 - 10
DOOR HARDWARE
1 SET SEALS 2525B BRN NGP
1 EA POWER SUPPLY PS902 GRY VON
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER WILL UNLOCK THE DOOR FOR ENTRY. THE INSIDE LEVER WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

HW SET: 08

1 EA CONTINUOUS HINGE 224HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA EU STOREROOM LOCK L9095LEU 03N 24VDC 626 SCH
2 EA MORTISE CYLINDER 1E74 626 BES
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA KICK PLATE 8400 10" X 2" LDW B-CS 630 IVE
1 SET SEALS 2525B BRN NGP
1 EA POWER SUPPLY PS902 GRY VON
2 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA REMOTE RELEASE BY SECURITY CONTRACTOR B/O
1 EA SCANNER SCAN II-B BLK SCE

OPERATION: THE CARD READER ON EACH SIDE OF THE DOOR OR THE REMOTE RELEASE WILL UNLOCK THE DOOR FOR ACCESS IN BOTH DIRECTIONS. THE MOTION SENSOR ON THE PUSH SIDE OF THE DOOR WILL UNLOCK THE DOOR FOR ENTRY INTO THE OFFICE DURING DAYTIME HOURS ONLY. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

HW SET: 09

3 EA HINGE 5BB1 4.5 X 4.5 652 IVE
1 EA OFFICE LOCK W/INDICATOR L9050L 03N L583-363 L283-711 626 SCH
1 EA MORTISE CYLINDER 1E74 626 BES
1 EA OVERHEAD STOP 100S 630 GLY

HW SET: 10

3 EA HINGE 5BB1 4.5 X 4.5 652 IVE
1 EA PASSAGE SET L9010 03N 626 SCH
1 EA OVERHEAD STOP 100S 630 GLY
HW SET: 11

1  EA CONTINUOUS HINGE 224HD 628 IVE
1  EA STOREROOM LOCK L9080L 03N 626 SCH
1  EA MORTISE CYLINDER 1E74 626 BES
1  EA SURFACE CLOSER 4040XP REG ST-1630 689 LCN
1  EA OVERHEAD STOP 100S 630 GLY
1  EA KICK PLATE 8400 10" X 2" LDW B-CS 630 IVE
1  SET SEALS 2525B BRN NGP

HW SET: 12

3  EA HINGE 5BB1 4.5 X 4.5 652 IVE
1  EA OFFICE LOCK W/INDICATOR L9050L 03N L583-363 L283-711 626 SCH
1  EA MORTISE CYLINDER 1E74 626 BES
1  EA WALL STOP WS33 626 IVE

HW SET: 13

1  EA CONTINUOUS HINGE 224HD 628 IVE
1  EA PRIVACY SET W/INDICATOR L9040 03N L583-363 L283-722 626 SCH
1  EA SURFACE CLOSER 4040XP REG 689 LCN
1  EA KICK PLATE 8400 10" X 2" LDW B-CS 630 IVE
1  EA WALL STOP WS33 626 IVE

HW SET: 14

1  EA CONTINUOUS HINGE 112HD-EPT 628 IVE
1  EA POWER TRANSFER EPT-10 689 VON
1  EA ELR PANIC HARDWARE QEL98EO 626 VON
1  EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1  EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1  EA ELECTRICAL DRAWING RISER DIAGRAM VON
1  EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1  EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1  EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 15.
HW SET: 15

1  EA CONTINUOUS HINGE  112HD-EPT628 IVE
1  EA POWER TRANSFER     EPT-10 689/VON
1  EA ELR PANIC HARDWARE  QEL98NL-OP  626/VON
1  EA RIM CYLINDER12E72   626/BES
1  EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628/B/O
1  EA AUTO-EQUALIZER 4642 REGARM 689/LCN
1  EA OVERHEAD STOP 900S 630/GLY
1  EA POWER SUPPLY PS906-4RL-4RL GRY VON
1  EA ELECTRICAL DRAWING RISER DIAGRAM VON
2  EA ACTUATOR, WALL MOUNT 8310-856T LCN
2  EA ESCUTCHEON 8310-874  630/LCN
1  EA CARD READER BY SECURITY CONTRACTOR  B/O
1  EA INTERCOM W/RELEASE BY SECURITY CONTRACTOR  B/O
1  EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR  B/O
1  EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR  B/O

OPERATION: THE CARD READER, REMOTE RELEASE, OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.

NOTE: THE PS906-4RL-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 14. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

HW SET: 16

1  EA CONTINUOUS HINGE  224HD-EPT628 IVE
1  EA POWER TRANSFER     EPT-10 689/VON
1  EA EU STOREROOM LOCK   L9092LEU 03N 24VDC 626/SCH
1  EA MORTISE CYLINDER   1E74   626/BES
1  EA SURFACE CLOSER      4040XP EDA  689/LCN
1  EA KICK PLATE          8400 10” X 2” LDW B-CS 630/VE
1  EA WALL STOP           WS33 626/IWE
1  SET SEALS 2525B BRN NGP
1  EA CARD READER BY SECURITY CONTRACTOR B/O
1  EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR  B/O

OPERATION: THE CARD READER WILL UNLOCK THE DOOR FOR ENTRY. THE INSIDE LEVER WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING.
HW SET: 17

3  EA HINGE 5BB1 4.5 X 4.5 652 IVE
1  EA STOREROOM LOCK L9080L 03N 626 SCH
1  EA MORTISE CYLINDER 1E74 626 BES
1  EA OVERHEAD STOP 100S 630 GLY

HW SET: 18

1  EA CONTINUOUS HINGE 112HD-EPT628 IVE
1  EA POWER TRANSFER EPT-10 689 VON
1  EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1  EA RIM CYLINDER 12E72 626 BES
1  EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1  EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1  EA OVERHEAD STOP 900S 630 GLY
1  EA DRIP CAP 16ACL NGP
1  EA DOOR SWEEP C627A CL NGP
1  EA THRESHOLD 8425 AL NGP
1  SET WEATHER SEAL BY FRAME MFR B/O
1  EA POWER SUPPLY PS904-4RL GRY VON
1  EA ELECTRICAL DRAWING RISER DIAGRAM VON
2  EA ACTUATOR, WALL MOUNT 8310-856 T LCN
2  EA ESCUTCHEON 8310-874 630 LCN
1  EA GRI 180-12 BY OWNER B/O
1  EA CARD READER BY SECURITY CONTRACTOR B/O
1  EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS904-4RL WILL ALSO SUPPLY POWER FOR DOOR(S) ASSIGNED TO HARDWARE SET 19. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 19

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 18.

HW SET: 20

2 EA CONTINUOUS 112HD 628 IVE
2 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
2 EA PUSH PLATE 8200 4" X 16" 630 IVE
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
1 EA ACTUATOR, JAMB MOUNT 8310-818T LCN

OPERATION: THE ACTIVATION SWITCHES ON BOTH SIDES WILL AUTOMATICALLY OPEN THE DOORS FOR ENTRY AND EGRESS. FREE EGRESS IS PERMITTED AT ALL TIMES.

HW SET: 21

1 EA CONTINUOUS HINGE 112HD PCO IVE
1 EA PANIC HARDWARE LD98NL-OP 626 VON
1 EA RIM CYLINDER12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 22

08 71 00 - 15
DOOR HARDWARE
08 71 00 - 16
DOOR HARDWARE

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 23

2 EA CONTINUOUS 112HD 628 IVE
2 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
2 EA PUSH PLATE 8200 4" X 16" 630 IVE
2 EA SURFACE CLOSER 4040XP SCUSH 689 LCN

HW SET: 24

1 EA CONTINUOUS HINGE 112HD-EPT 628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA GRI 180-12 BY OWNER B/O
1 EA POWER SUPPLY PS902-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA INTERCOM W/RELEASE BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER, ACCESS CONTROL SCHEDULE, OR REMOTE RELEASE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS902-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 25. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

HW SET: 25

1 EA CONTINUOUS HINGE 112HD-EPT 628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED Flush PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 24.

HW SET: 26

1 EA CONTINUOUS 112HD 628 IVE
1 EA PANIC HARDWARE LD98EO 626 VON
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 27

2 EA CONTINUOUS HINGE 112HD PCO IVE
1 EA KEYED REM MULLION SL-60-KR 628 SPE
2 EA PANIC HARDWARE LD98EO 626 VON
1 EA MORTISE CYLINDER 1E74 626 BES
2 EA RECESSED Flush PULL BY DOOR MANUFACTURER 628 B/O
2 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
2 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
2 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCHES ARE MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 28

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES

08 71 00 - 17
DOOR HARDWARE
1. **Recessed Flush Pull** by Door Manufacturer 628/B
2. **Auto-Equalizer** 4642 Regarm 689/LCN
3. **Overhead Stop** 9005 630/GLY
4. **Drill Cap** 16ACL NGP
5. **Door Sweep C627A** CL NGP
6. **Threshold** 8425 AL NGP
7. **Weather Seal** by Frame Mfr. B/O
8. **Power Supply** PS904-4RL-4RL GRY VON
9. **Electrical Drawing Riser Diagram** VON
10. **Actuator, Jamb Mount** 8310-818T LCN
11. **Actuator, Wall Mount** 8310-856T LCN
12. **Bollard Post** B-6SQ-RT-SM-SG 630/WK
13. **Gri 180-12 By Owner** B/O
14. **Card Reader** By Security Contractor B/O
15. **Intercom W/Release** By Security Contractor B/O
16. **Scheduled Unlocking** By Security Contractor B/O

**OPERATION:** The card reader, remote release, or access control schedule will electrically unlatch the door for entry. When the door is unlatched, the outside activation switch is enabled and will initiate the barrier free operator to automatically open the door. The inside activation switch will remain operable at all times to perform the same function for egress. The panic hardware will permit free egress at all times. The door position switch is monitored by the access control system.

**NOTE:** The PS904-4RL-4RL will also supply power for door(s) assigned to hardware set 29. Prior to issuing the bid proposal, the hardware supplier shall consult with the factory to ensure the specified power supply is sufficient for all related doors and operations required.

**HW SET: 29**

1. **Continuous Hinge** 112HD-EPT628/VE
2. **Power Transfer** EPT-10 689/VON
3. **ELR Panic Hardware** QEL98EO 626/VON
4. **Recessed Flush Pull** by Door Manufacturer 628/B/O
5. **Surface Closer** 4040XP SCUSH 689/LCN
6. **Drill Cap** 16ACL NGP
7. **Door Sweep C627A** CL NGP
8. **Threshold** 8425 AL NGP
9. **Weather Seal** by Frame Mfr. B/O
10. **Electrical Drawing Riser Diagram** VON
11. **Gri 180-12 By Owner** B/O
12. **Scheduled Unlocking** By Security Contractor B/O
13. **Power Supply** Furnished in Other Hardware Set B/O

**OPERATION:** The access control schedule will electrically unlatch the door for entry. The panic hardware will permit free egress at all times. The door position switch is monitored by the access control system.

**NOTE:** The power supply is furnished in hardware set 28.
## DW Set: 30

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Make</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous 112HD</td>
<td>628 IVE</td>
<td>1 EA</td>
</tr>
<tr>
<td>Recessed Flush Pull</td>
<td>628 B/O</td>
<td>1 EA</td>
</tr>
<tr>
<td>Push Plate</td>
<td>8200 4&quot; X 16&quot;</td>
<td>1 EA</td>
</tr>
<tr>
<td>Auto-Equalizer</td>
<td>4642 Regarm 689 LCN</td>
<td>1 EA</td>
</tr>
<tr>
<td>Overhead Stop</td>
<td>900S 630 GLY</td>
<td>2 EA</td>
</tr>
<tr>
<td>Actuator, Jamb Mount</td>
<td>8310-818T LCN</td>
<td>1 EA</td>
</tr>
</tbody>
</table>

**Operation:** The activation switches on both sides will automatically open the doors for entry and egress. Free egress is permitted at all times.

## DW Set: 31

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Make</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous 112HD</td>
<td>628 IVE</td>
<td>1 EA</td>
</tr>
<tr>
<td>Recessed Flush Pull</td>
<td>628 B/O</td>
<td>1 EA</td>
</tr>
<tr>
<td>Push Plate</td>
<td>8200 4&quot; X 16&quot;</td>
<td>1 EA</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>4040XP SCUSH 689 LCN</td>
<td>1 EA</td>
</tr>
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</table>

## DW Set: 32

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Make</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>224HD 628 IVE</td>
<td>1 EA</td>
</tr>
<tr>
<td>Panic Hardware</td>
<td>LD98EO 626 VON</td>
<td>1 EA</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>4040XP SCUSH ST-1595 689 LCN</td>
<td>1 EA</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>8400 10&quot; X 2&quot; LDW B-CS 630 IVE</td>
<td>1 EA</td>
</tr>
<tr>
<td>Set Seals</td>
<td>700NA CL NGP</td>
<td>1 SET</td>
</tr>
<tr>
<td>Drip Cap</td>
<td>16ACL NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>Door Sweep</td>
<td>C627A CL NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>Threshold</td>
<td>8425 AL NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>GRI</td>
<td>180-12 BY OWNER B/O</td>
<td>2 EA</td>
</tr>
</tbody>
</table>

**Operation:** The door position switch is monitored by the access control system.

## DW Set: 33

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Make</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>224HD 628 IVE</td>
<td>2 EA</td>
</tr>
<tr>
<td>Mullion</td>
<td>KR4954 689 VON</td>
<td>1 EA</td>
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<tr>
<td>Panic Hardware</td>
<td>LD98EO 626 VON</td>
<td>2 EA</td>
</tr>
<tr>
<td>Mortise Cylinder</td>
<td>1E74 626 BES</td>
<td>1 EA</td>
</tr>
<tr>
<td>Mullion Seal</td>
<td>5100N BLK NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>4040XP SCUSH ST-1595 689 LCN</td>
<td>2 EA</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>8400 10&quot; X 2&quot; LDW B-CS 630 IVE</td>
<td>2 EA</td>
</tr>
<tr>
<td>Set Seals</td>
<td>700NA CL NGP</td>
<td>1 SET</td>
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<tr>
<td>Drip Cap</td>
<td>16ACL NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>Door Sweep</td>
<td>C627A CL NGP</td>
<td>2 EA</td>
</tr>
<tr>
<td>Threshold</td>
<td>8425 AL NGP</td>
<td>1 EA</td>
</tr>
<tr>
<td>GRI</td>
<td>180-12 BY OWNER B/O</td>
<td>2 EA</td>
</tr>
</tbody>
</table>

**Operation:** The door position switches are monitored by the access control system.
HW SET: 34

1  EA CONTINUOUS HINGE  224HD   628 IVE
1  EA STOREROOM LOCK  L9080L 03N   626 SCH
1  EA MORTISE CYLINDER  1E74   626 BES
1  EA SURFACE CLOSER    4040XP SCUSH ST-1595   689 LCN
1  EA KICK PLATE       8400 10" X 2" LDW B-CS   630 IVE
1  SET SEALS 700NA CL NGP
1  EA DRIP CAP     16ACL NGP
1  EA DOOR SWEEP C627A CL NGP
1  EA THRESHOLD      8425 AL NGP
1  EA LOCK GUARD LG12 630 IVE
1  EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 35

1  EA CONTINUOUS HINGE  224HD-EPT628 IVE
1  EA POWER TRANSFER  EPT-10 689 VON
1  EA EU STOREROOM LOCK  L9092LEU 03N 24VDC 626 SCH
1  EA MORTISE CYLINDER  1E74   626 BES
1  EA SURFACE CLOSER    4040XP SCUSH ST-1595   689 LCN
1  EA KICK PLATE       8400 10" X 2" LDW B-CS   630 IVE
1  SET SEALS 700NA CL NGP
1  EA DRIP CAP     16ACL NGP
1  EA DOOR SWEEP C627A CL NGP
1  EA THRESHOLD      8425 AL NGP
1  EA LOCK GUARD LG12 630 IVE
1  EA POWER SUPPLY PS902 GRY VON
1  EA GRI 180-12 BY OWNER B/O

OPERATION: THE CARD READER WILL UNLOCK THE DOOR FOR ENTRY. THE INSIDE LEVER WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 36

2  EA CONTINUOUS HINGE  224HD   628 IVE
2  EA MANUAL FLUSH BOLT FB458 626 IVE
1  EA DUST PROOF STRIKE DP1   626 IVE
1  EA STOREROOM LOCK    L9080L 03N   626 SCH
1  EA MORTISE CYLINDER  1E74   626 BES
1  EA ASTRAGAL178SA CL NGP
2  EA SURFACE CLOSER    4040XP SCUSH ST-1595 689 LCN
2  EA KICK PLATE       8400 10" X 2" LDW B-CS   630 IVE
1  SET SEALS 700NA CL NGP
1  EA DRIP CAP     16ACL NGP
2  EA DOOR SWEEP C627A CL NGP
1  EA THRESHOLD      8425 AL NGP

08 71 00 - 20
DOOR HARDWARE
Detroit Public Schools Community District

Issued for: PERMIT/BID SET

Stantec Architecture
Stantec Project Number 214100569
2022.06.21

1 EA Z ASTRAGAL BY DOOR MFR. B/O
2 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: INSTALL THE 178SA ON THE PULL SIDE OF THE ACTIVE DOOR.

HW SET: 37

1 EA CONTINUOUS HINGE 112HD-EPT628IVE
1 EA POWER TRANSFER EPT-10 689VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626VON
1 EA RIM CYLINDER12ET2  626BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628B/O
1 EA AUTO-EQUALIZER 4642 REGARM 689LCN
1 EA OVERHEAD STOP 900S 630GLY
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS904-4RL-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630LCN
1 EA BOLLARD POST B-6SQ-RT-SM-SG 630WIK
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS904-4RL-4RL WILL ALSO SUPPLY POWER FOR DOOR(S) ASSIGNED TO HARDWARE SET 38. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 38

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 37.

HW SET: 39

1 EA CONTINUOUS 112HD 628 IVE
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630 LCN

OPERATION: THE ACTIVATION SWITCHES ON BOTH SIDES WILL AUTOMATICALLY OPEN THE DOORS FOR ENTRY AND EGRESS. FREE EGRESS IS PERMITTED AT ALL TIMES.

HW SET: 40

2 EA CONTINUOUS HINGE 112HD PCO IVE
1 EA KEYED REM MULLION SL-60-KR 628 SPE
2 EA PANIC HARDWARE LD98EO 626 VON
1 EA MORTISE CYLINDER 1E74 626 BES
2 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
2 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
2 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCHES ARE MONITORED BY THE ACCESS CONTROL SYSTEM.

08 71 00 - 22
DOOR HARDWARE
HW SET: 41

<table>
<thead>
<tr>
<th>Item</th>
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<td>Panic Lever Trim</td>
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<td>R/V</td>
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<tr>
<td>1</td>
<td>Rim Cylinder</td>
<td>12E72</td>
<td>626 BES</td>
<td>1</td>
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<td>1</td>
<td>Surface Closer</td>
<td>4040XP REG ST-1630</td>
<td>689 LCN</td>
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<td>1</td>
<td>Overhead Stop</td>
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<td>630 GLY</td>
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<td>Door Sweep</td>
<td>200SA</td>
<td>CL</td>
<td>NGP</td>
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<td>AL</td>
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<td>By Frame MFR.</td>
<td>B/O</td>
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<tr>
<td>1</td>
<td>Gri</td>
<td>180-12</td>
<td>By Owner</td>
<td>B/O</td>
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**Operation:** The door position switch is monitored by the access control system. Note: Install the door sweep on the pull side of the door.

HW SET: 42

<table>
<thead>
<tr>
<th>Item</th>
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<th>Quantity</th>
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<tr>
<td>1</td>
<td>Panic Hardware</td>
<td>LD98L-NL</td>
<td>626 VON</td>
<td>1</td>
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<tr>
<td>1</td>
<td>Rim Cylinder</td>
<td>12E72</td>
<td>626 BES</td>
<td>1</td>
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<tr>
<td>1</td>
<td>Surface Closer</td>
<td>4040XP SCUSH</td>
<td>689 LCN</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Kick Plate</td>
<td>8400 10” X 2”</td>
<td>LDW B-CS</td>
<td>630 IVE</td>
</tr>
</tbody>
</table>
HW SET: 43

2 EA CONTINUOUS HINGE 112HD-EPT628 IV E
2 EA POWER TRANSFER EPT-10 689 VON
1 EA KEYED REM MULLION SL-60-KR 628 SPE
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA MORTISE CYLINDER 1E74 626 BES
2 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
1 EA DRIP CAP 16ACL NGP
2 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS904-4RL-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630 LCN
2 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA INTERCOM W/RELEASE BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER, REMOTE RELEASE, OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCHES ARE MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 44

1 EA CONTINUOUS HINGE  112HD-EPT628 IVE
1 EA POWER TRANSFER   EPT-10 689 VON
1 EA ELR PANIC HARDWARE  QEL98NL-OP  626 VON
1 EA RIM CYLINDER12E72  626 BES
1 EA RECESSED FLUSH PULL  BY DOOR MANUFACTURER  628 B/O
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S   630 GLY
1 EA DRIP CAP  16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD  8425 AL NGP
1 SET WEATHER SEAL  BY FRAME MFR.  B/O
1 EA POWER SUPPLY  PS904-4RL-4RL  GRY VON
1 EA ELECTRICAL DRAWING  RISER DIAGRAM  VON
1 EA ACTUATOR, WALL MOUNT  8310-856T  LCN
1 EA ESCUTCHEON  8310-874  630 LCN
1 EA GRI 180-12 BY OWNER  B/O
1 EA CARD READER  BY SECURITY CONTRACTOR  B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR  B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS904-4RL-4RL WILL ALSO SUPPLY POWER FOR DOOR(S) ASSIGNED TO HARDWARE SET 45. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 45

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 44.

HW SET: 46

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS902-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER, OR THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS902-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 47. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 47

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL-98EO 626 VON
1 EA DECESS FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040 XP SCUSH 689 LCN
1 EA DRIP CAP 16 ACL NGP
1 EA DOOR SLEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 46.

HW SET: 48

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL-98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA DECESS FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040 XP SCUSH 689 LCN
1 EA DRIP CAP 16 ACL NGP
1 EA DOOR SLEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS902-2RS GRY VON
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

PRIOR TO FURNISHING THE POWER SUPPLY, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
**DOOR HARDWARE**

**HW SET: 49**

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<th>Item Description</th>
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<th>Supplier</th>
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<td>628 IVE</td>
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<td>Panic Hardware</td>
<td>LD98NL-OP</td>
<td>626 VON</td>
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<tr>
<td>Rim Cylinder</td>
<td>12E72</td>
<td>626 BES</td>
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<tr>
<td>Door Pull</td>
<td>VR910NL</td>
<td>630 IVE</td>
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<td>Surface Closer</td>
<td>4040XP SCUSH</td>
<td>ST-1595</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>8400 10&quot; X 2&quot;</td>
<td>LDW B-CS</td>
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<td>Seals</td>
<td>700NA CL</td>
<td>NGP</td>
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<tr>
<td>Drap Cap</td>
<td>16ACL</td>
<td>NGP</td>
</tr>
<tr>
<td>Door Sweep</td>
<td>C627A CL</td>
<td>NGP</td>
</tr>
<tr>
<td>Threshold</td>
<td>8425 AL</td>
<td>NGP</td>
</tr>
<tr>
<td>GRI 180-12 by Owner</td>
<td>B/O</td>
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**Operation:** The door position switch is monitored by the access control system.

**HW SET: 50**

<table>
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<td>628 IVE</td>
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<td>Power Transfer</td>
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<td>Rim Cylinder</td>
<td>12E72</td>
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<td>Mortise Cylinder</td>
<td>1E74</td>
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<td>689 LCN</td>
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<td>Drap Cap</td>
<td>16ACL</td>
<td>NGP</td>
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<tr>
<td>Door Sweep</td>
<td>C627A CL</td>
<td>NGP</td>
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<td>Threshold</td>
<td>8425 AL</td>
<td>NGP</td>
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<td>Card Reader</td>
<td>BY SECURITY CONTRACTOR</td>
<td>B/O</td>
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<tr>
<td>Intercom W/Release</td>
<td>BY SECURITY CONTRACTOR</td>
<td>B/O</td>
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</table>

**Operation:** The card reader will electrically unlatch the door for entry. The panic hardware will permit free egress at all times. The door position switches are monitored by the access control system.

**Note:** Prior to issuing the bid proposal, the hardware supplier shall consult with the factory to ensure the specified power supply is sufficient for all related doors and operations required.
1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS902-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA ACTUATOR, WALL MOUNT 8310-856T LCN
1 EA ESCUTCHEON 8310-874 630 LCN
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
DOOR HARDWARE

HW SET: 52

2 EA CONTINUOUS HINGE  224HD  628 IVE
1 EA MULLION KR4954   689 VON
1 EA PANIC HARDWARE  LD98EO  626 VON
1 EA PANIC HARDWARE  LD98NL-OP  626 VON
1 EA RIM CYLINDER 12E72   626 BES
1 EA MORTISE CYLINDER 1E74   626 BES
1 EA DOOR PULL VR910NL    630 IVE
1 EA MULLION SEAL 5100N  BLK   NGP
2 EA SURFACE CLOSER  4040XP SCUSH ST-1595  689 LCN
2 EA KICK PLATE  8400 10" X 2" LDW B-CS  630 IVE
1 SET SEALS 700NA  CL   NGP
1 EA DRIP CAP 16ACL  NGP
2 EA DOOR SWEEP C627A  CL   NGP
1 EA THRESHOLD 8425  AL   NGP
2 EA GRI 180-12 BY OWNER  B/O

OPERATION: THE DOOR POSITION SWITCHES ARE MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 53

1 EA CONTINUOUS 112HD   628 IVE
1 EA STOREROOM LOCK L9080L 03N  626 SCH
1 EA MORTISE CYLINDER 1E74   626 BES
1 EA SURFACE CLOSER  4040XP SCUSH  689 LCN
1 EA DRIP CAP 16ACL  NGP
1 EA DOOR SWEEP C627A  CL   NGP
1 EA THRESHOLD 8425  AL   NGP
1 SET WEATHER SEAL BY FRAME MFR.  B/O
1 EA LOCK GUARD LG12    630 IVE
1 EA GRI 180-12 BY OWNER  B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.
### HW SET: 54

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<td>Surface Closer 4040XP SCUSH ST-1595 689 LCN</td>
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<td>Seals 700NA CL NGP</td>
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<td>DRIP CAP 16ACL NGP</td>
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<td>1</td>
<td>Door Sweep C627A CL NGP</td>
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<td>Threshold 8425 AL NGP</td>
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<td>1</td>
<td>GRI 180-12 BY OWNER B/O</td>
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Operation: The door position switch is monitored by the access control system.

**Note:** Field verify existing frame for hardware compatibility prior to submitting bid. When retrofitting hardware for existing frames, patch, modify, and repair as required. The contractor is responsible for notifying the architect of hardware conflicts prior to submitting bid proposal. The bid proposal shall include additional costs as required for materials or hardware not included in door schedule or hardware specification. This includes new doors and frames if necessary. When applicable, all work performed on fire-rated assemblies shall be in accordance with NFPA 80.

### HW SET: 55

<table>
<thead>
<tr>
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<td>1</td>
<td>Surface Closer 4040XP SCUSH ST-1595 689 LCN</td>
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<td>1</td>
<td>Seals 700NA CL NGP</td>
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<td>1</td>
<td>DRIP CAP 16ACL NGP</td>
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<td>Door Sweep C627A CL NGP</td>
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<td>1</td>
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<tr>
<td>1</td>
<td>GRI 180-12 BY OWNER B/O</td>
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Operation: The door position switch is monitored by the access control system.
HW SET: 56

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA POWER SUPPLY PS904-4RL GRY VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER, OR THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE PS904-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 56. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

HW SET: 57

1 EA CONTINUOUS HINGE 112HD-EPT628 IVE
1 EA POWER TRANSFER EPT-10 689 VON
1 EA ELR PANIC HARDWARE QEL98EO 626 VON
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 EA GRI 180-12 BY OWNER B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 56.
DOOR HARDWARE

HW SET: 58

1 EA CONTINUOUS HINGE 112HD PCO IVE
1 EA STOREROOM LOCK L9080L 03N 626 SCH
1 EA MORTISE CYLINDER 1E74 626 BES
1 EA SURFACE CLOSER 4040XP SCUSH ST-1595 689 LCN
1 SET SEALS 700NA CL NGP
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 EA LOCK GUARD LG12 630 IVE
1 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

HW SET: 59

1 EA CONTINUOUS HINGE 112HD PCO IVE
1 EA PANIC HARDWARE LD98NL-OP 626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA HOLD-OPEN CLOSER 4040XP SCUSH ST-1595 689 LCN
1 SET SEALS 700NA CL NGP
1 EA DRIP CAP 16ACL NGP
1 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 425HD AL NGP
1 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: FIELD VERIFY EXISTING FRAME FOR HARDWARE COMPATIBILITY PRIOR TO SUBMITTING BID. WHEN RETROFITTING HARDWARE FOR EXISTING FRAMES; PATCH, MODIFY, AND REPAIR AS REQUIRED. THE CONTRACTOR IS RESPONSIBLE FOR NOTIFYING THE ARCHITECT OF HARDWARE CONFLICTS PRIOR TO SUBMITTING BID PROPOSAL. THE BID PROPOSAL SHALL INCLUDE ADDITIONAL COSTS AS REQUIRED FOR MATERIALS OR HARDWARE NOT INCLUDED IN DOOR SCHEDULE OR HARDWARE SPECIFICATION. THIS INCLUDES NEW DOORS AND FRAMES IF NECESSARY. WHEN APPLICABLE, ALL WORK PERFORMED ON FIRE-RATED ASSEMBLIES SHALL BE IN ACCORDANCE WITH NFPA 80.
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NOTE: FIELD VERIFY EXISTING FRAME FOR HARDWARE COMPATIBILITY PRIOR TO SUBMITTING BID. WHEN RETROFITTING HARDWARE FOR EXISTING FRAMES; PATCH, MODIFY, AND REPAIR AS REQUIRED. THE CONTRACTOR IS RESPONSIBLE FOR NOTIFYING THE ARCHITECT OF HARDWARE CONFLICTS PRIOR TO SUBMITTING BID PROPOSAL. THE BID PROPOSAL SHALL INCLUDE ADDITIONAL COSTS AS REQUIRED FOR MATERIALS OR HARDWARE NOT INCLUDED IN DOOR SCHEDULE OR HARDWARE SPECIFICATION. THIS INCLUDES NEW FRAMES IF NECESSARY. WHEN APPLICABLE, ALL WORK PERFORMED ON FIRE-RATED ASSEMBLIES SHALL BE IN ACCORDANCE WITH NFPA 80.

**Operation:** The door position switch is monitored by the access control system.
HW SET: 62

2 EA CONTINUOUS 112HD 628 IVE
2 EA MANUAL FLUSH BOLT FB458 626 IVE
1 EA DUST PROOF STRIKE DP1 626 IVE
1 EA PANIC HARDWARE LD9875NL-OP 626 VON
1 EA MORTISE CYLINDER 1E74 626 BES
1 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA ASTRAGAL 178SA CL NGP
2 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA DRIP CAP 16ACL NGP
2 EA DOOR SWEEP C627A CL NGP
1 EA THRESHOLD 8425 AL NGP
1 SET WEATHER SEAL BY FRAME MFR. B/O
2 EA GRI 180-12 BY OWNER B/O

OPERATION: THE DOOR POSITION SWITCHES ARE MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: INSTALL THE 178SA ON THE PULL SIDE OF THE ACTIVE DOOR.

HW SET: 63

2 EA CONTINUOUS 112HD 628 IVE
2 EA RECESSED FLUSH PULL BY DOOR MANUFACTURER 628 B/O
1 EA SURFACE CLOSER 4040XP SCUSH 689 LCN
1 EA AUTO-EQUALIZER 4642 REGARM 689 LCN
1 EA OVERHEAD STOP 900S 630 GLY
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630 LCN

OPERATION: THE ACTIVATION SWITCHES ON BOTH SIDES WILL AUTOMATICALLY OPEN THE DOORS FOR ENTRY AND EGRESS. FREE EGRESS IS PERMITTED AT ALL TIMES.
DW SET: 64

1 SET HANGING DEVICE W/ EPT BY DOOR MFR. 628 B/O
1 EA POWER TRANSFER BY DOOR MFR. 689 B/O
1 EA ELR FIRE EXIT HARDWARE QEL98NL-F626 VON
1 EA RIM CYLINDER 12E72 626 BES
1 EA LOW ENERGY OPERATOR BESAM SW200I 628 BSM
1 SET SEALS BY DOOR MFR. B/O
1 EA POWER SUPPLY PS906-4RL-4RL GR Y VON
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
2 EA ACTUATOR, WALL MOUNT 8310-856T LCN
2 EA ESCUTCHEON 8310-874 630 LCN
1 SET FIRE ALARM RELAY BY FIRE ALARM CONTRACTOR B/O
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA INTERCOM W/RELEASE BY SECURITY CONTRACTOR B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O

OPERATION: THE CARD READER, REMOTE RELEASE, OR ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH IS ALWAYS OPERABLE TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING. THE ELECTRONIC LATCH AND AUTOMATIC OPERATOR WILL BE CONNECTED TO THE FIRE ALARM PANEL TO CUT POWER AND PERMIT THE DOOR TO CLOSE AND LATCH UPON ACTIVATION.

NOTE: THE PS906-4RL-4RL WILL ALSO SUPPLY POWER FOR DOORS ASSIGNED TO HARDWARE SET 65. PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.
HW SET: 65

1 SET HANGING DEVICE W/ EPT BY DOOR MFR. 628 B/O
1 EA POWER TRANSFER BY DOOR MFR. 689 B/O
1 EA ELR FIRE EXIT HARDWARE QEL98DT-F626 VON
1 EA LOW ENERGY OPERATOR BESAM SW200I 628 BSM
1 SET SEALS BY DOOR MFR. B/O
1 EA ELECTRICAL DRAWING RISER DIAGRAM VON
1 SET FIRE ALARM RELAY BY FIRE ALARM CONTRACTOR B/O
1 EA REMOTE LOCKDOWN BY SECURITY CONTRACTOR B/O
1 EA SCHEDULED UNLOCKING BY SECURITY CONTRACTOR B/O
1 EA ACTIVATION SWITCHES FURNISHED IN HARDWARE SET 064 B/O
1 EA POWER SUPPLY FURNISHED IN OTHER HARDWARE SET B/O

OPERATION: THE ACCESS CONTROL SCHEDULE WILL ELECTRICALLY UNLATCH THE DOOR FOR ENTRY. WHEN THE DOOR IS UNLATCHED, THE OUTSIDE ACTIVATION SWITCH IS ENABLED AND WILL INITIATE THE BARRIER FREE OPERATOR TO AUTOMATICALLY OPEN THE DOOR. THE INSIDE ACTIVATION SWITCH IS ALWAYS OPERABLE TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE ELECTRONIC HARDWARE CAN BE REMOTELY LOCKED TO OVERRIDE ALL ELECTRONIC UNLOCKING. THE ELECTRONIC LATCH AND AUTOMATIC OPERATOR WILL BE CONNECTED TO THE FIRE ALARM PANEL TO CUT POWER AND PERMIT THE DOOR TO CLOSE AND LATCH UPON ACTIVATION.

NOTE: THE POWER SUPPLY IS FURNISHED IN HARDWARE SET 64.
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<tr>
<td>1</td>
<td>EA GRI 180-12 BY OWNER B/O</td>
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</table>

OPERATION: THE KEYSWITCH WILL ENABLE THE OUTSIDE ACTIVATION SWITCH TO ELECTRICALLY UNLATCH AND AUTOMATICALLY OPEN THE DOOR FOR ENTRY. THE INSIDE ACTIVATION SWITCH WILL REMAIN OPERABLE AT ALL TIMES TO PERFORM THE SAME FUNCTION FOR EGRESS. THE PANIC HARDWARE WILL PERMIT FREE EGRESS AT ALL TIMES. THE DOOR POSITION SWITCH IS MONITORED BY THE ACCESS CONTROL SYSTEM.

NOTE: PRIOR TO ISSUING THE BID PROPOSAL, THE HARDWARE SUPPLIER SHALL CONSULT WITH THE FACTORY TO ENSURE THE SPECIFIED POWER SUPPLY IS SUFFICIENT FOR ALL RELATED DOORS AND OPERATIONS REQUIRED.

END OF SECTION 08 71 00
SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes glazing product and glazing requirements for the following:
   1. Monolithic clear float glass.
   2. Insulating glass units.
   3. Fire-rated glazing.
   4. Glazing materials and accessories.

B. Products Specified in Other Sections for Installation Under This Section:
   1. Install glazing sealant specified in Div. 07 Section "JOINT SEALANTS."

C. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 02-49 Sections specifying glass and glazing by reference to this Section.

1.02 REFERENCES

A. Definitions:
   1. Glass: Includes glass and other glazing products.
   2. Glass Manufacturers: Firms that produce primary float glass as defined in referenced glazing publications.
   3. Glass Fabricators: Firms that fabricate glass and related materials into glazing units.
   4. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
   5. Fire-Protection-Rated Glazing: Glazing capable of confining a fire for a prescribed period of time stated in minutes when tested per NFPA 252 or NFPA 257.
   6. Fire-Resistance-Rated Glazing: Glazing capable of preventing or retarding the passage of excessive heat, hot gases or flames for a prescribed period of time stated in minutes when tested per ASTM E119.
   7. IGU: Insulating glass unit.
   8. Interspace: Space between lites of an insulating-glass unit.
   9. Refer to referenced glazing publications for glazing terms not otherwise defined herein or in referenced standards

B. Reference Standards and Glazing Publications: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   3. Glass Association of North America (GANA):
1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section. In addition to other items, review and discuss GANA GM Chapter IX "General Guidelines for Glazing."

B. Coordination: Coordinate glass sizes with framing specified in other Sections. Coordinate glazing channel dimensions for glazing to provide required bite on glazing unit, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances as required per applicable testing requirements in referenced standards.

1.04 SUBMITTALS, GENERAL

B. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:
   1. Performance data for individual panes of glass and for fully fabricated glass units with specified coatings.
   2. Drawings and descriptive and performance data for IGU spacers.

B. Samples: For each type and thickness of the following products visible in the finished Work for verification.
   1. Fully fabricated glazing units, except non-fire-protection-rated clear single-pane vision glass.
   2. Gaskets.
   3. IGU spacers.
   5. Sample Size:
      a. 12 inches square for glass.
      b. 12 inches in length for linear materials.

C. Product schedule for glazing units in format and with data similar to attached "GLAZING UNIT SCHEDULES" listing glass types and thicknesses for each size opening and location. Replace "Basis of Design" product with actual product provided. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product certificates for glass and glazing products.

B. Delegated-design submittal per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS."
   Include design data for the following for which design is assigned to Contractor.
   1. Wind load design of vertical glass.

C. Test and Evaluation Reports:
   1. Preconstruction compatibility and adhesion test reports for sealants in contact with glass.
   2. Product test reports for coated glass, glazing sealants, and glazing gaskets.

D. Manufacturers’ instructions for .
   1. Indicate by transmittal that copies of instructions and recommendations have been distributed to installer.
E. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.06 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Fabricator Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A firm or individual certified, licensed, or otherwise qualified by glass manufacturer as experienced and with sufficient trained staff to fabricate products specified in this Section and whose products have a record of successful in-service performance.
   2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A firm who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   3. Glass Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and accredited per NFRC 702 Certification Agency Program.

B. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Test glazing sealants for compatibility with and adhesion to actual substrates to be installed per Div. 07 Section "JOINT SEALANTS."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Protect glazing materials in accordance with manufacturer's written instructions.
   2. Protect glass and glazing materials from damage due to precipitation, condensation, temperature changes, direct exposure to sun, or other causes per manufacturer's written instructions.
   3. Protect glass from contact with contaminating substances resulting from construction operations including, but not limited to, weld splatter, fire-safing, plastering, and mortar droppings.
   4. Comply with IGU fabricator's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.08 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Minimum Conditions: Do not install glazing when ambient and/or substrate temperatures are outside limits permitted by sealant or glazing material manufacturers or when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   2. Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during remainder of construction period.
1.09 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard "CLOSEOUT PROCEDURES" providing coverage against failure, defects, or deterioration as follows:
   1. Form: Manufacturer's standard.
   2. Deterioration of glazing is defined as defects developed from normal use that are not attributed to breakage or to maintaining and cleaning glazing units contrary to manufacturer's written instructions.
   3. Coated-Glass Products: Defects include peeling, cracking, and other indications of deterioration in coating. Provide products to replace failed units.
      a. Warranty Period: 10 years from date of Substantial Completion.
   4. Insulating Glass: Defects include failure of hermetic seal evidenced by dust, moisture, or film on interior surfaces of glass. Provide products to replace failed units.
      a. Warranty Period: 10 years from date of Substantial Completion.
   5. Fire-Rated Glazing:
      a. Laminated Glass: Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard. Provide products to replace failed units.
         1) Warranty Period: 5 years from date of Substantial Completion.
      b. Multi-Layer Units with Gel Fill: Evidence of failure is the leakage of gel fill from units, air bubbles within units, or obstruction of vision by contamination or deterioration of gel.
         1) Warranty Period: 10 years from date of Substantial Completion.
      c. Tempered Glazing Units with Clear Intumescent Interlayer:
         1) Warranty Period: 5 years from date of Substantial Completion.
      d. Fire-Protection-Rated Tempered Glass:
         1) Warranty Period: Lifetime for glazing unit. 10 years from date of Substantial Completion for insulated make-ups.
      e. Specialty Fire-Protective Glazing:
         1) Warranty Period: Lifetime for glazing unit.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. Float Glass Manufacturers:
      a. AGC Glass North America, Inc.
      b. Cardinal Glass Industries.
      c. Guardian Glass, LLC.
      d. Pilkington North America, Inc.
      e. Vitro Architectural Glass (formerly PPG Glass).
      f. Comparable products by other manufacturers will be considered.
   2. Fire-Protection-Rated Glazing Manufacturers:
a. InterEdge, Inc., a subsidiary of AFG Industries, Inc.
b. Safti First.
c. Technical Glass Products.
d. Vetrotech Saint-Gobain NA.
e. Comparable products by other manufacturers will be considered.

B. Acceptable Glazing Unit Fabricators: Certified by flat glass manufacturer for type of glass, coating, and treatment involved, and capable of providing specified warranty.

C. Source Limitations for Glazing: Obtain each glazing unit type other than monolithic clear from single source from single manufacturer/fabricator.
   1. Obtain secondary and incidental glazing materials from single source from single manufacturer approved by glass manufacturer and fabricator.

2.03 DESCRIPTION

A. Product Options: Information on Drawings and in Specifications establishes requirements for glazing aesthetic effects and performance characteristics. Aesthetic effects are indicated by glazing units scheduled. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects or performance characteristics, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

B. Regulatory Requirements:
   1. Safety Glazing: Where safety rated glazing is indicated or required by authorities having jurisdiction, provide glazing that complies with Class A per ANSI Z97.1-2015 or Category II per CPSC 16 CFR 1201.
      a. Labeling: Permanently mark safety glazing per ANSI Z97.1-2015 or with certification label of the SGCC or the manufacturer. Label shall include manufacturer's name, type of glazing, thickness, and safety glazing standard(s) with which glass complies.

2.04 PERFORMANCE AND DESIGN CRITERIA

A. Performance Requirements: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to:
   1. defective manufacture, fabrication, or installation;
   2. failure of sealants or gaskets to remain watertight and airtight;
   3. deterioration of glazing materials; or
   4. other defects in glazing work.

B. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design the following aspects of glazing, using performance requirements and design criteria specified herein.
   1. Delegated Design: Design glass, including comprehensive engineering analysis according to Michigan Building Code and ASTM E1300 by a qualified professional engineer, using design criteria herein:

C. Structural Performance: Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
1. Design Wind Pressures: As indicated on Drawings.
2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
   a. Glass thicknesses indicated are minimums.
   b. Glass strengths indicated are minimums. Provide Kind HS or Kind FT glass as needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with performance and design criteria.
3. Thermal Movements: Provide exterior glazing to withstand thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.
   a. Temperature Change: 120 deg F, ambient differential; 180 deg F, material surface differential.

**D. Thermal and Optical Performance:** Provide glass with performance properties indicated. Performance properties are nominal, unless otherwise indicated, and are per manufacturer’s published data as determined by the following procedures and/or test methods:
1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. Values for the following calculated using LBNL’s WINDOW 7.7 software.
   a. Center of Glass U-Factors: Per NFRC 100.
   c. Center of Glass Visible Transmittance ($T_{vis}$): Per NFRC 200.
   d. Center of Glass Visible Reflectance ($R_{vis}$): Per NFRC 300.

**2.05 MONOLITHIC FLOAT GLASS**

**A. Annealed Glass:** ASTM C1036, Type I, Quality-Q3, Class 1 clear, unless otherwise indicated.

**B. Heat-Treated Glass:** ASTM C1048; Type I; Quality-Q3; Class 1 clear, unless otherwise indicated; Kind HS or Kind FT as indicated or required; Condition A for uncoated glass, Condition C for coated vision glass.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

**C. Solar Control Low-E Reflective-Coated Vision Glass:** ASTM C1376, coated by vacuum (sputtering) deposition method.

**2.06 INSULATING GLASS**

**A. Insulating-Glass Units:** Factory-assembled units, qualified according to ASTM E2190.
1. Sealing System: Dual seal, with polyisobutylene primary seal and manufacturer's standard secondary seal.
2. Thermally Improved Hybrid Metal Spacer: Stainless steel spacer bar profile combined with a non-thermal-bridging insulating plastic top.
3. Desiccant: Molecular sieve or silica gel, or blend of both.

**B. Permanently mark, either on spacers or on at least one component lite of units, with appropriate certification label of IGCC.**
2.07 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Ratings: Provide fire-protection-rated glazing listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-ratings indicated based on testing as follows:

1. Fire-Protection-Rated Glazing for Door Assemblies: Tested per NFPA 252 or UL 10C based on positive-pressure testing, including hose-stream test, and shall comply with NFPA 80 and 16 CFR 1201, Category II.
   a. Fire-protection-rated door glazing required to have a fire-protection rating of 20 minutes (D-20 label) shall be exempt from hose-stream test.

2. Fire-Protection-Rated Glazing for Window Assemblies (including transoms, sidelights, and windows): Tested per NFPA 257 or UL 9 including hose-stream test.

3. Labeling, General: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, fire test standard, and the following:
   a. Fire-Protection-Rated Glazing:
      1) Indicate whether glazing is permitted to be used in doors or openings and, if permitted, whether glazing has passed hose-stream test.
      2) Indicate whether glazing meets 450 deg F temperature-rise limitation.
      3) Indicate fire-protection rating in minutes.

B. Provide fire-protection-rated glazing manufactured, fabricated and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

C. Specialty Tempered Glass for 20-Minute Doors tested without hose stream: Fully tempered monolithic glass, 5- to 6-mm thickness.
   2. Basis-of-Design Product: SuperLite I or SuperLite I-XL by SAFTI FIRST Fire Rated Glazing Solutions or comparable product by one of the following:
      a. Technical Glass Products.
      b. Vetrotech Saint-Gobain.

D. Specialty Tempered Glass for 45-Minute Protected Openings: Fully tempered, monolithic ultraclear low-iron glass, 19-mm thickness.
   1. Opening Fire-Protection Ratings: D-H-OH-45 or OH-45

2.08 FIRE-RESISTANCE-RATED GLAZING

A. Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-resistance ratings indicated, based on testing in accordance with ASTM E119 or UL 263.
   1. Framing: Fire-resistance-rated glazing with 60-minute ratings requires framing from glass supplier, tested as an assembly complying with ASTM E119 or UL 263.

B. Glazing Labeling: Permanently mark fire-resistance-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, that glazing is approved for use in walls, and fire-resistance rating in minutes.

C. Tempered Glazing Units with Clear Intumescent Interlayer: Glazing units made from two lites of uncoated, fully tempered, clear float glass; with a perimeter edge seal enclosing a cavity filled with optically clear, semi-solid, intumescent polymer.

2.09 GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standards and combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials for application indicated, and with a proven record of compatibility with fabricated glass, sealants, gaskets, and other materials used in the glazing operation.
   1. For fire-protection-rated glazing, provide products which are approved by testing agency that listed and labeled the fire-protection-rated glazing product with which they are used for application and fire-protection rating indicated.

B. Gaskets, Setting Blocks, Edge Blocks, and Spacer Shims: Per GANA GM, ASTM C864 or ASTM C1115 and combined requirements of glass and framing system manufacturers.
   1. Glazing Gaskets: Molded or extruded; shape to suit glazing channel retaining slot; hardness required to maintain watertight seal.
   2. Setting Blocks: Elastomeric material of hardness of size required.
   3. Edge Blocks: Elastomeric material of hardness and size required to limit glass lateral movement (side walking).
   4. Spacer Shims: Elastomeric blocks or continuous extrusions of hardness and size required to maintain glass lites in place.

C. Glazing Sealants: Compatible with adjacent materials, suitable for applications indicated and for conditions existing at time of installation, and complying with requirements in Div. 07 Section “JOINT SEALANTS.”

D. Back Bedding Mastic Type Glazing Tapes: Preformed, butyl-based, 100 percent solids.
   1. Per AAMA 804.3 for back bedding and drop-in glazing applications in light commercial fenestration products.
   2. Per AAMA 806.3 where tape is subjected to continuous pressure exerted from gaskets or pressure generating stop designs.
   3. Per AAMA 807.3 which tape is not subjected to continuous pressure from gaskets or pressure generating stop designs.

E. Expanded Cellular Type Glazing Tapes:
   1. Per AAMA 810.1, Type II for systems where tape is the secondary sealant used in combination with a full bead of wet sealant.

F. Perimeter Insulation for Fire-Rated Glazing: Product approved by testing agency that listed and labeled fire-protection-rated glazing product with which it is used for application and fire-protection rating indicated.

G. Cleaners, Primers, and Sealers: Types recommended by sealant and gasket manufacturer.

2.10 ACCESSORIES

A. Distraction Markers / Glazing Awareness Signage: Patterned or frosted bands or images of window film bonded to glass surfaces with semi-permanent adhesives for alerting pedestrians to presence of glazing in doors and sidelights and glass walls capable of being mistaken for a passageway.
   1. Manufacturers:
      a. Capitol Marking Products.
      b. CHB industries.
      c. Color Reflections.
d. Distraction Graphics.
e. MetWest.
f. Comparable products by other manufacturers will be considered.


3. Pattern: As selected by Architect and approved by Owner. Where indicated to be installed on both sides of glass, patterns shall be reverse images appearing the same when viewed through the glass.

4. Provide sign materials with instructions for field application after glazing is installed.

2.11 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, and to comply with system performance requirements.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine conditions, with Installer present, for compliance with requirements.

1. Verify openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.

2. Verify glazing channels are of proper depth and stops are of height to provide proper bite on glazing units.

3. Verify required face and edge clearances is provided.

4. Verify joints of framing members are effectively sealed and weep system is present and functioning.

5. Verify surfaces of glazing channels or recesses are clean; free of burrs, projections, and obstructions that may impede moisture movement; weeps are clear; and support framing is ready to receive glazing system.

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

7. Verify exterior and interior surfaces of glazing units. Label or mark units so surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

C. Clean glazing units and framing contact surfaces with appropriate solvent and wipe dry immediately before glazing. Remove coatings that are not tightly bonded to substrates.

D. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

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

F. Protect glazing unit edges from damage during handling and installation. Remove damaged glazing units from Project site and legally dispose of off Project site. Damage includes edge damage or other imperfections that, when installed, could weaken glazing units and impair performance and appearance.
3.02 GLAZING, GENERAL

A. Install glazing per GANA GM and combined written instructions of manufacturers of glazing units, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced standards and glazing publications.

B. Install setting blocks in sill rabbets set in thin course of heel bead sealant.

C. Install edge blocking on dry glazed systems and where required to prevent glazing units from moving sideways in glazing channel.

D. Install continuous or intermittent spacer shims for glazing units lites where required to maintain required face clearances, unless gaskets and/or glazing tapes are used that have demonstrated ability to maintain required face clearances.
   1. Where used as backing for sealant cap bead, install continuous spacer shims, or intermittent spacer shims combined with cylindrical sealant backing, between glazing units and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems.
   2. Secure spacer shims and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

E. Set glazing units per GANA GM procedures applicable to glazing method.

F. Compress gaskets and glazing tapes to produce a weathertight seal without developing bending stresses in glazing units. Do not exceed edge pressures stipulated by glazing unit manufacturers for installing glazing units.

G. Set glazing units in each series with uniform pattern, draw, bow, and similar characteristics.

H. Set glazing units in proper orientation so coatings face direction specified.

I. Do not field cut, drill, snip, or otherwise modify heat-treated or fire-protection-rated glazing units.

3.03 WET GLAZING

A. Applications: Wood and metal doors, sidelights, and borrowed lights without gaskets.

B. Pre-Formed Tape: Position tape on fixed stops so that, when compressed by glazing unit, exposed tape edges are flush with or protrude slightly above sightline of stops.
   1. At wood framing, use tape with or without integral, continuous shim.
   2. At metal framing without gaskets, use tape with integral, continuous shim.
   3. Install tape in continuous lengths, without joints, along each glazing unit edge.
   4. Apply toe and heel bead of sealant where indicated.
   5. Apply sealant cap bead on both sides of glazing unit where indicated.

C. Gunnable Elastomeric Sealant: Ensure complete wetting or bond of sealant to glazing unit and channel surfaces. Do not block glazing channel weeps with sealant.
   1. Toe Beads: Where indicated, required, or recommended by framing manufacturer, apply a continuous toe bead of non-curing-type sealant in glazing channels before or as glazing unit is installed, in a bead large enough to contact the edge of the glazing unit after setting the glazing unit as a secondary seal against water penetration.
2. **Heel Beads:** Where indicated, required, or recommended by framing manufacturer, apply a continuous heel bead of non-curing-type sealant in glazing channels to eliminate voids and to act as a secondary seal in prime sealed framing systems against water penetration.

3. **Cap Beads:** At hollow metal and other framing without gaskets, apply curing-type sealant over glazing tape as a primary seal against water penetration. Tool exposed surfaces of sealants to provide a substantial wash away from glazing unit.

### 3.04 DRY GLAZING

**A. Applications:** Aluminum-framed entrances, storefronts, curtain wall, and windows.

**B. Gasket Glazing:** Cut gaskets to lengths recommended by gasket manufacturer to fit openings with allowance for relaxing during installation and shrinkage. Where gasket corners are not molded or vulcanized, cut and bond gasket corners to form continuous, joint-free perimeter seal.

1. Install soft gaskets between glazing unit and frame or fixed stop per GANA GM procedure.

2. Where dense wedge-shaped gaskets are installed 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.

3. Install removable stops without displacing gaskets; exert uniform pressure for full continuous contact without developing bending stresses in glazing unit.

### 3.05 PRESSURE GLAZING

**A. Applications:** Aluminum-framed curtainwall.

**B. Install pressure-glazing stops applying pressure uniformly to compression gaskets.**

**C. Install gasketed pressure plates and tighten fasteners systematically at rate recommended by manufacturer to uniformly compress gaskets while avoiding creating point pressures on glazing unit. Torque fasteners to achieve final required pressure against glazing unit without over tightening.**

### 3.06 INTERIOR GLAZING

**A. Glaze wood doors and frames with removable glazing stops by GANA GM Wood Method B (wet).**

**B. Glaze non-fire-rated hollow metal doors and frames with removable glazing stops by GANA GM Hollow Metal Method C (wet / tape).**

**C. Glaze fire-rated hollow metal doors and frames by methods approved by testing agencies that listed and labeled fire-resistant glazing products.**

### 3.07 ACCESSORY INSTALLATION

**A. Glazing Awareness Signage:** Apply warning decal signage to glass on one side to make it obvious it is not a passageway.

1. Apply signage at a height of 60 inches and 30 inches above floor with not more than 6 inches of open glass between individual sign elements.

2. Applications: Where the presence of glass in a door or sidelight or glass wall capable of being mistaken for a doorway or opening is not made apparent by horizontal mullion bars
or other components of the glazing system, or other decorative treatment such as being opaque or patterned

3.08 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Wash glazing 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 glazing as recommended in writing by glazing product manufacturer.

3.09 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Protect glazing from damage immediately after installation by attaching crossed streamers to framing held away from glazing units. Do not apply markers to glazing surface. Remove nonpermanent labels and clean surfaces.

C. Protect glazing from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glazing, remove substances immediately as recommended in writing by glazing material manufacturer.

D. Examine glazing 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 glazing material manufacturer.

E. Remove and replace glazing that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

3.10 ATTACHMENTS

A. "MONOLITHIC GLAZING UNIT SCHEDULE."

B. "INSULATING GLAZING UNIT SCHEDULE."

C. "FIRE-RATED GLAZING UNIT SCHEDULE."

END OF SECTION 08 80 00
# MONOLITHIC GLAZING UNIT SCHEDULE

<table>
<thead>
<tr>
<th>Identifier (MG-#)</th>
<th>Tint Color</th>
<th>Type</th>
<th>Unit Thickness (inch)</th>
<th>Strength</th>
<th>Coating</th>
<th>U-factor</th>
<th>SHGC</th>
<th>Transmittance (Tvis)</th>
<th>Reflectance (Rvis)</th>
<th>Basis of Design</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>MG-1</td>
<td>Clear</td>
<td>V</td>
<td>6</td>
<td>A</td>
<td>None</td>
<td>1.025</td>
<td>0.818</td>
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<td>Generic</td>
<td></td>
</tr>
<tr>
<td>MG-1T</td>
<td>Clear</td>
<td>SV</td>
<td>6</td>
<td>FT</td>
<td>None</td>
<td>1.025</td>
<td>0.818</td>
<td>88.36%</td>
<td>8.04%</td>
<td>Generic</td>
<td></td>
</tr>
</tbody>
</table>

## NOTES / ABBREVIATIONS

- V = Vision lite
- SV = Safety vision lite, CPSC Cat. II impact-safety rated.
- A = Annealed
- FT = Fully tempered

END OF SCHEDULE 08 80 00.13

C:\Dropbox\ABA\Specifications Projects\2022\2022.S14 DPSCD PS104 Spec\2022-06-09_90% IR & 06-16 100%\(08 80 00.13_wsx glazing unit schedule.xlsx\)FIRE-RATED 2018 (2)
### INSULATING GLAZING UNIT SCHEDULE

<table>
<thead>
<tr>
<th>Identifier (IGU-#)</th>
<th>Color (Out./In.)</th>
<th>Type</th>
<th>Unit Thickness (inch)</th>
<th>Strength (O / I)</th>
<th>Outboard Lite (mm)</th>
<th>Interspace (mm)</th>
<th>Interspace Content</th>
<th>Inboard Lite (mm)</th>
<th>Coating</th>
<th>U-factor</th>
<th>SHGC</th>
<th>Transmittance % (Tvis)</th>
<th>Reflectance % (Rvis)</th>
<th>Basis of Design</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGU-1</td>
<td>Starphire / Starphire</td>
<td>V</td>
<td>1</td>
<td>HS / A</td>
<td>6</td>
<td>1/2</td>
<td>Air</td>
<td>6</td>
<td>Low-E</td>
<td>0.293</td>
<td>0.390</td>
<td>73.03%</td>
<td>10.41%</td>
<td>Viracon VE2-2M</td>
<td>Low-E on No. 2</td>
</tr>
<tr>
<td>IGU-1T</td>
<td>Starphire / Starphire</td>
<td>SV</td>
<td>1</td>
<td>FT / FT</td>
<td>6</td>
<td>1/2</td>
<td>Air</td>
<td>6</td>
<td>Low-E</td>
<td>0.293</td>
<td>0.390</td>
<td>73.03%</td>
<td>10.41%</td>
<td>Viracon VE2-2M</td>
<td>Low-E on No. 2</td>
</tr>
</tbody>
</table>

### NOTES / ABBREVIATIONS

V = Vision lite  
SV = Safety vision lite, CPSC Cat. II impact-safety rated.  
A = Annealed  
HS = Heat-strengthened  
FT = Fully tempered  
Air = Air filled interspace

END OF SCHEDULE 08 80 00.15
# FIRE-RATED GLAZING UNIT SCHEDULE

<table>
<thead>
<tr>
<th>Identifier (FRG#)</th>
<th>Location and Fire Rating in Hours</th>
<th>DOORS (D)</th>
<th>SIDE LIGHTS &amp; TRANSOMS</th>
<th>WINDOWS (OH) &amp; WALLS (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FG-1</td>
<td>1 Hour Corridor Wall Doors</td>
<td>Min. Rating (minutes)</td>
<td>Vision Panel Size (sq in)</td>
<td>Glazing Type</td>
</tr>
<tr>
<td>FG-2</td>
<td>1 Hour Corridor Wall Sidelights</td>
<td>20</td>
<td>Max</td>
<td>SV</td>
</tr>
<tr>
<td>FG-3</td>
<td>1 Hour Corridor Wall Windows</td>
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<td></td>
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## FIRE PARTITIONS

<table>
<thead>
<tr>
<th>Identifier (FRG#)</th>
<th>Location and Fire Rating in Hours</th>
<th>DOORS (D)</th>
<th>SIDE LIGHTS &amp; TRANSOMS</th>
<th>WINDOWS (OH) &amp; WALLS (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FG-1</td>
<td>1 Hour Corridor Wall Doors</td>
<td>Min. Rating (minutes)</td>
<td>Vision Panel Size (sq in)</td>
<td>Glazing Type</td>
</tr>
<tr>
<td>FG-2</td>
<td>1 Hour Corridor Wall Sidelights</td>
<td>20</td>
<td>Max</td>
<td>SV</td>
</tr>
<tr>
<td>FG-3</td>
<td>1 Hour Corridor Wall Windows</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## NOTES AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>Greater than 100 sq in for door vision lites to the maximum lite size tested and passing ASTM E 119 or UL 263 test requirements</td>
</tr>
<tr>
<td>V b</td>
<td>Vision lite - Where safety rated glazing is indicated or required, provide SV.</td>
</tr>
<tr>
<td>SV</td>
<td>Safety vision lite, CPSC Cat. II impact-safety rated.</td>
</tr>
</tbody>
</table>

END OF SCHEDULE 08 80 00.17
SECTION 08 91 19 - FIXED LOUVERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes fixed, extruded-aluminum louvers.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
3. Div. 08 Section "HOLLOW METAL DOORS AND FRAMES" for louvers in hollow-metal doors.
4. Div. 08 Section "FLUSH WOOD DOORS" for louvers in flush wood doors.

1.02 REFERENCES

A. Definitions:
1. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
2. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
3. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

C. Samples: For each type and color of metal finish required.

08 91 19 - 1
FIXED LOUVERS
1.06 INFORMATIONAL SUBMITTALS

A. Delegated-design submittal per Div. 01 Section "DELEGATED DESIGN REQUIREMENTS." Include design data for products indicated to comply with design loads for which design is assigned to Contractor.

B. Test and Evaluation Reports: As follows:
   1. Product Test Reports: Based on evaluation of comprehensive tests performed per AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. Airolite Company, LLC (The).
   2. Construction Specialties, Inc.
   4. Reliable Products, Inc.
   5. Ruskin Company; Tomkins PLC.
   6. Comparable products by other manufacturers will be considered.

B. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.03 PERFORMANCE / DESIGN CRITERIA

A. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design louvers, using performance requirements and design criteria specified herein.

B. Structural Performance Requirements: Provide louvers, including anchorages, capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors.
   1. Design Wind Loads: As indicated on Drawings.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width per AMCA 500-L.
D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.


2.04 HORIZONTAL, EXTRUDED-ALUMINUM LOUVERS

A. Drainable-Blade Louver:
   2. Louver Depth: 4 inches.
   3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
   4. Mullion Type: Concealed.
   5. AMCA Certified Louver Performance Ratings:
      a. Free Area: Not less than 8.9 sq. ft. (56 percent) for 48 inch square louver.
      b. Maximum Allowable Pressure Drop: Not more than 0.07 inch wg static pressure drop at 6000 cfm intake velocity.
      c. Pressure Drop at Beginning Point of Water Penetration: Not more than 0.16 inch wg.
      d. Beginning Point of Water Penetration: Not less than 989 fpm.
   6. Louvers shall be licensed to bear the AMCA Certified Ratings Program seal for air performance and water penetration per AMCA Publication 511.

B. Glazed-In Drainable-Blade Louver (at Keidan Special Education Center):
   2. Louver Depth: 4 inches.
   3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
   4. Provide glazing adapter in outer frame flange to allow glazing louver unit into storefront or curtain wall framing.
   5. Provide side-hinged louver units for exterior access to mechanical units behind louvers.
   7. Double-Wide Hinged Unit Locking: Overlapping mullion, lockable with padlock hasp and with top and bottom barrel slide bolts on interior of one unit.
   8. AMCA Certified Louver Performance Ratings:
      a. Free Area: Not less than 8.0 sq. ft. (50 percent) for 48 inch square louver.
      b. Maximum Allowable Pressure Drop: Not more than 0.098 inch wg static pressure drop at 6000 cfm intake velocity.
      c. Pressure Drop at Beginning Point of Water Penetration: Not more than 0.18 inch wg.
      d. Beginning Point of Water Penetration: Not less than 1007 fpm.
   9. Louvers shall be licensed to bear the AMCA Certified Ratings Program seal for air performance and water penetration per AMCA Publication 511.

2.05 LOUVER SCREENS

A. General: Provide screen at louvers indicated. Omit screens at louvers backed by filters or at blank-off panels.
   1. Screen Location for Fixed Louvers: Interior face.
   2. Screen Type: Bird screening where connected to mechanical ductwork; insect screening where not connected to mechanical ductwork.

B. Louver Screening for Aluminum Louvers:
   1. Bird Screening: Aluminum, 1/2 inch square mesh, 0.063 inch wire.
   2. Insect Screening: Aluminum, 18-by-16 mesh, 0.012 inch wire.
C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
   1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
   2. Finish: Mill finish unless otherwise indicated.
   3. Type: Rewirable frames with a driven spline or insert for insect screens; non-rewirable, folded U-shaped frames for bird screens.

D. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at not more than 12 inches o.c. along each edge.

2.06 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.
   1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   2. For exposed fasteners use tamper-resistant screws with heads that match color of louvers, unless otherwise indicated.

D. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.07 FABRICATION

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication, and indicate measurements on Shop Drawings.

B. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Channel unless otherwise indicated.
   2. Include matching sill flashing.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
   1. Concealed Mullions: Where indicated, provide mullions fully or partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds
fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.

G. Provide subsills made of same material as louvers or extended sills for recessed louvers.

H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view or threaded fasteners or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.08 ALUMINUM FINISHES

A. Superior-Performance Organic Finish: As specified in Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."
   1. Finish louvers after assembly.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

D. Coordinate setting drawings, diagrams, templates, directions for installation of anchorages that are to be embedded in concrete or masonry construction, and instructions. Coordinate delivery of such items to Project site.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

C. Use concealed anchorages where possible. Provide resilient gasket washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

D. Form closely fitted joints with exposed connections accurately located and secured.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Protect metal louver surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Div. 07 Section "JOINT SEALANTS" for sealants applied during louver installation.
3.03  REPAIR

A. Touchup Painting: Immediately after erection, touch up shop-applied primers per Div. 05 Section "SHOP-APPLIED PRIME COATINGS FOR METAL."

B. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.04  CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

END OF SECTION 08 91 19
SECTION 09 05 61 - COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes requirements for preparing new and existing concrete substrates for installation of the following types of floor coverings:
   1. Thin-set tile as specified in Div. 09 Section "TILING."
   2. Resilient floor coverings as specified in Div. 09 Section "RESILIENT FLOORING".
   3. Carpet as specified in Div. 09 Section "CARPETING."

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 03 Section "CAST-IN-PLACE CONCRETE" for concrete substrate flatness, levelness, and finish.
   4. Div. 02 through 49 Sections specifying floor substrate preparation work by referencing this Section.

1.02 REFERENCES

A. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
      a. ASTM F710: Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
      b. ASTM F1869: Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   3. Resilient Floor Covering Institute (RFCI):

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS ADMINISTRATIVE REQUIREMENTS" minimum one week prior to placing concrete floor slabs.
   1. Attendees: Architect, Contractor, and Owner and representatives of firms removing existing floor coverings, firms placing and finishing concrete, and firms installing floor coverings.
   2. Include representatives of and firms installing affected floor coverings.
   3. Discuss conditions at time of concrete placement, concrete slab flatness and levelness expectations, substrate evaluation and assessment procedures, and the various allowable remediation procedures which may be required.
a. Determine, in advance, responsibilities of the various trades for floor substrate preparation.

B. Coordinate work of flooring trades involved to comply with specified requirements.

C. Sequencing: Perform floor preparation operations per Div. 01 Section "PROJECT COORDINATION" and in the following order:
   1. Evaluate and assess condition of concrete floor substrates, including both on-grade and elevated slabs:
      a. At existing concrete with existing floor coverings:
         1) Evaluate and assess condition of existing floor coverings.
      b. At existing and new concrete:
         1) Evaluate and assess presence of penetrating coatings or sealers/hardeners/dustproofers.
         2) Verify floor flatness and levelness requirements were achieved.
   4. Remove existing floor covering as specified.
   5. Perform cleaning and preparation.
   6. Perform moisture vapor emission tests.
   7. Perform internal relative humidity tests.
   8. Perform alkalinity (pH) tests.
  10. Perform specified remediation, if required based on results of testing.
  11. Protect floor substrates until floor coverings are installed.

C. Scheduling: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Schedule cleaning and testing, so preliminary cleaning is completed at least 24 hours prior to testing.

1.02 SUBMITTALS, GENERAL
   A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES;"

1.03 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. For floor covering and adhesive manufacturers’ product literature, identify each specific combination of substrate, floor covering, and adhesive to be used showing moisture and alkalinity (pH) limits and test methods and manufacturer's required bond/compatibility test procedure.
      2. For remediation materials, include:
         a. Manufacturer's qualification statement.
         b. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.

1.04 INFORMATIONAL SUBMITTALS
   A. Test and Evaluation Reports: As follows:
      1. Visual observation report for existing floor coverings to be removed.
      2. Preconstruction test reports for floor substrates including:
         a. Description of areas tested with notated floor plans and photographs.
         b. Summary of conditions encountered.
         c. Moisture and alkalinity (pH) test reports.
         d. Copies of specified test methods.
         e. Recommendations for remediation of unsatisfactory surfaces.
         f. Submit report not more than two business days after conclusion of testing.
3. Mockup test reports for floor substrates including:
   a. Means and methods of application.
   b. Products used.
   c. Project-specific conditions being addressed.
   d. Standardized tests performed for each proposed system or variation.

4. Product test reports for adhesive bond and compatibility.

B. Manufacturers’ instructions.

C. Sample warranties.

D. Qualification Statements for manufacturers, installer, Contractor's testing agency.
   1. Include manufacturer's approval for installer.

1.05 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
   2. Specialty Firm Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: A firm specializing in remedial repairs to concrete as specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   3. Remedial Coating Installer Qualifications: Minimum 3 years experience under current organizational structure.
      a. Company: An employer of workers trained and approved by manufacturer for installation of Products specified in this Section.
      b. Project Experience: Minimum 3 years experience on at least 5 projects of similar nature in past 3 years.
      c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.
   4. Contractor's Testing Agency Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS".
   5. Manufacturer's Technical Representative Qualifications: Minimum 3 years experience with manufacturer of Products specified in this Section.

B. Field Mockups: Per Div. 01 Section "MOCKUPS" and as follows:
   1. Location: As directed.
   2. Size: Minimum 100 sq. ft. for each combination of moisture mitigation system and floor covering to be applied.
   3. Perform tests specified in TESTING CONCRETE SLABS Article below in order listed.
   4. Test tensile bond strength of the moisture mitigation system to the concrete substrate per ASTM D7234.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Maintain ambient temperature between 65 and 85 deg F and relative humidity between 40 and 60 percent in spaces where concrete testing is to be performed for the following time periods:
   a. 48 hours before testing.
   b. During testing.

PART 2 - PRODUCTS

2.01 MATERIALS

   1. For carpet removal, comply with Carpet and Rug Institute "Carpet Installation Standard."

B. Trowelable Leveling and Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of product recommendation from flooring manufacturer, provide with the following characteristics:
   1. Latex- or polyvinyl-acetate-modified, Portland cement based or blended hydraulic-
cement-based formulation;
   2. Moisture-, mold-, mildew-, and alkali-resistant compound;
   3. Free of gypsum content;
   4. Compatible with substrate, floor covering, and floor covering adhesive;
   5. Capable of being feathered at edges.
   6. Compressive Strength: 3000 psi, minimum, after 28 days, when tested per ASTM C109/C109M.

C. Alternate Flooring Adhesive: Adhesive manufacturer's recommended product, suitable for the conditions existing at time of installation, and acceptable to floor covering manufacturer. When possible, provide adhesive recommended by floor covering manufacturer.
   1. Moisture Tolerant Adhesive: Resistant to the levels of moisture present.
   2. High or Low pH Tolerant Adhesive: Resistant to the level of alkalinity present.

D. Moisture Mitigation System: ASTM F3010; single- or multi-layer 100% solids epoxy coating or coating/underlayment combination intended by its manufacturer to resist moisture vapor emission to degree sufficient to meet floor covering manufacturer's emission limits; resistant to the level of alkalinity (pH) found; and suitable for adhesion of floor covering without further treatment.
   1. Thickness: As required for application and in accordance with manufacturer's installation instruction.
   2. Provide products recommended by testing agency, if any.
   3. Products:
      a. TechMVC Moisture Vapor and Alkalinity Barrier with Silk Patching & Finishing Compound by Custom Building Products.
      b. VAP I® 2000 with Koster SL Premium overlay by KOSTER American.
      c. Laticrete NXT Vapor Reduction Coating with Laticrete NXT Level Plus by Laticrete International, Inc.
      d. Moisture Guard Max by ProSpec, an H.B. Fuller Construction Products brand.
      e. USG Durock™ Brand RH-100™ Moisture Vapor Reducer by United States Gypsum Company.
      f. Comparable products by other manufacturers will be considered.

E. Hydraulic Cement-Based Self-Leveling Underlayment: Provide product manufactured or approved by moisture mitigation system and floor covering manufacturers.
1. Description: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
2. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
3. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
4. Aggregate: Well-graded, coarse sand as recommended by underlayment manufacturer. Provide washed gravel at thicker applications as recommended by manufacturer.
5. Performance and Physical Properties: Meet or exceed the following values for cured material:
   a. Compressive Strength: Minimum 4,000 psi at 28 days per ASTM C109/109M.
   b. Flexural Strength: 1000 psi at 28 days per ASTM C78.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine substrates, with floor covering installers and floor covering manufacturer’s representatives present, for compliance with requirements and conditions affecting performance of the Work.
   2. Visually observe and evaluate existing floor coverings for adhesion, water and other damage, alkaline deposits, and other defects.
   3. Visually observe and evaluate existing and new concrete floors to determine type of applied treatments or coatings, if any.
   4. Ensure substrates are structurally sound and meet flatness requirements of floor covering manufacturers and as follows:
      a. For Tile Flooring:
         1) Small Tile: For tiles with edges shorter than 15 inch, maximum 1/4 inch in 10 feet from the required plane, with no more than 1/16 inch variation in 12 inches from the required plane, when measured from the high points in the surface.
         2) Large Tile: For tiles with at least one edge 15 inch in length, maximum 1/8 inch in 10 feet from the required plane, with no more than 1/16 inch variation in 24 inches from the required plane, when measured from the high points in the surface.
      b. For Resilient Flooring: Maximum 3/16 inch in 10 feet in any direction and within the equivalent of 1/32 inch in 12 inches.
      c. For Carpet: Maximum 1/4 inch in 10 feet in any direction.
   5. Obtain recommendations, in writing, from installers and floor covering manufacturer's representatives on floor preparation procedures.
   6. Proceed with installation of floor coverings only after unsatisfactory conditions have been corrected.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with federal, State, and local regulations and recommendations in ASTM F 710.

B. Resilient Floor Coverings: Remove loose, damaged, and deteriorated floor coverings and adhesive per recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."
3.03 PRELIMINARY CLEANING

A. Clean floors using approved OSHA work practices. Comply with standards referenced herein.

B. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

C. Do not use solvents or other chemicals for cleaning.

D. Do not use sweeping compounds in areas to receive adhesive-applied floor coverings.

3.04 CONCRETE PREPARATION

A. Comply with applicable requirements of ASTM F710 and requirements and recommendations of floor covering manufacturer, except delay installation of leveling and patching compound until after testing and remediation work, if any, unless otherwise required by referenced standards or product manufacturers.

B. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by manufacturer. Do not use solvents.

3.05 TESTING, GENERAL

A. See Div. 01 Section "QUALITY REQUIREMENTS" for administrative and procedural requirements for obtaining services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing Agency:
   1. Engage a qualified independent testing and inspecting agency to perform moisture and concrete alkalinity (pH) tests and to prepare reports.
   2. Engage a qualified independent testing and inspecting agency to perform adhesive and bond tests and to prepare reports. At Contractor's option, adhesive and bond test may be performed by Contractor's personnel.

C. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Confirm date of start of testing at least 7 days prior to actual start.
   2. Allow at least 4 working days on site for testing agency activities.
   3. Achieve and maintain specified ambient conditions.
   4. Notify Architect when specified ambient conditions have been achieved and when testing will start.

D. Where the floor covering manufacturer's requirements conflict with either the referenced test methods or this Section, comply with the manufacturer's requirements.
3.06 TESTING CONCRETE FLOORS

A. Moisture Vapor Emission Test: Test per ASTM F1869.
   1. In the event test values exceed floor covering manufacturer's limits, perform remediation as indicated below. In the absence of floor covering manufacturer limits, perform remediation if test values exceed 3 pounds per 1,000 square feet in 24 hours.

B. Internal Relative Humidity Test: Test per ASTM F2170 Procedure A or Procedure B.
   1. Perform tests in same locations as moisture vapor emission tests, unless otherwise indicated.
   2. In the event test values exceed floor covering manufacturer's limits, perform remediation as indicated below. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

C. Surface Alkalinity Test
   2. Test No. 2: Test as follows:
      a. Clean the surface using a wire brush. Be sure to remove dirt, concrete sealer, and old adhesive residue.
      b. Gather 0.5 g (0.018 oz) of concrete powder by hand sanding an approximately 2 inch square area with 50-grit general-purpose sandpaper.
      c. Thoroughly mix the concrete powder with 10 to 12 drops of fresh distilled water with a small, flat plastic stirrer. Let stand for 60 seconds.
      d. Insert a pH strip into the mixture. Compare the strip to the color chart to determine the pH.
      e. Record the temperature of the concrete surface.
   3. Perform tests in same locations as moisture vapor emission tests, unless otherwise indicated.
   4. In the event test values exceed floor covering manufacturer's limits, perform remediation as indicated below. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is below 7.0 or over 10.0.

D. Adhesive Bond And Compatibility Testing: Test per requirements and recommendations of floor covering manufacturer.

3.07 REMEDIATION OF CONCRETE FLOOR SLABS

A. Perform remediation due to unsatisfactory results of testing and to correct floor surface roughness.
   1. If remediation is recommended by testing agency's report and is due to a condition beyond Contractor's control or which could not have been predicted by examination prior to entering into the Contract, a Contract Modification will be issued.

B. When active water leaks or continuing moisture migration to surface of slab occur, correct such conditions before performing remediation work. Repeat testing as specified above after correcting condition.

C. Contractor Remediation Options:
   1. When test results indicate excessive moisture emission or internal relative humidity alternate moisture tolerant adhesive may be provided, if available; otherwise apply moisture mitigation system over entire suspect floor area.
   2. When test results indicate pH of concrete surface is outside acceptable range, alternate high or low pH tolerant adhesive may be provided, if available; otherwise apply moisture mitigation system over entire suspect floor area.
3. When test results indicate poor adhesive bond, perform remedial procedures per requirements and recommendations of floor covering manufacturer.

D. Moisture Mitigation System Application: Comply with ASTM F3010, recommendations of testing agency, and moisture mitigation system manufacturer’s written instructions based on test results.
   1. Allow proper curing time and observe moisture mitigation system manufacturer’s time limits for leaving moisture mitigation system exposed prior to installation of floor coverings.

E. Correcting Floor Surface Roughness: When concrete surfaces to receive floor coverings exhibit irregularities, roughness, or other defects capable of telegraphing through new flooring, perform remedial measures as required to achieve acceptable surface profiles.
   1. Minor repairs using trowelable leveling and patching compound are, within reason, by the individual floor covering Sections.
   2. For Slabs on Ground: Acceptable remedial measures include grinding, planing, surface repair, retopping, or removal and replacement by specialty firms.
   3. For Suspended Slabs: Limit remedial measures to grinding or use of an underlayment or topping material by specialty firms.

F. Underlayment Installation: When underlayment is required on top of the moisture mitigation system, install per moisture mitigation system and underlayment manufacturer’s instructions. Allow to cure and dry before proceeding with floor covering installation.

G. See individual floor covering Sections for additional requirements.

3.08 CLEANING

A. Sweep and vacuum clean substrates to be covered by flooring immediately before installation.

3.09 PROTECTION

A. Protect prepared substrates and applied moisture mitigation system from traffic, dust, debris, water and any other contaminants until installation of underlayments, if any, and floor coverings.

END OF SECTION 09 05 61
COMMERCIAL WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION
SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel wall framing systems.
   2. Suspension systems for interior ceilings.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Division 05 Section "Cold-Formed Metal Framing" for exterior and structural interior framing.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS and as follows:

B. Protect steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 MANUFACTURERS

A. Manufacturers: Members of the SSMA and the following:
   2. Marino/WARE.
   3. Comparable products by other manufacturers will be considered.

2.03 DESCRIPTION

A. Non-structural cold-formed metal framing includes, but is not limited to, the following:
   1. Interior non-load-bearing wall framing.
   2. Interior ceiling framing.

2.04 PERFORMANCE AND DESIGN CRITERIA

C. Delegated Design: Professional design services are specifically required of Contractor. Engage a qualified design professional, as defined in Div. 01 Section "DELEGATED DESIGN REQUIREMENTS," to design non-structural metal framing, using performance requirements and design criteria specified herein.
   1. Unless more stringent requirements are indicated, comply with AISI S100 and AISI S220.
   2. Design framing to maintain clearances at openings, to allow for construction tolerances.
   3. Design framing to accommodate live load deflection of primary building structure of 1 inch.
   4. Design framing to support loads and moments imposed by wall-mounted items indicated on Drawings including, but not limited to, heavy trim, counters, shelving, cabinets, fixtures, handrails, grab bars, toilet accessories, equipment services, furnishings, or similar construction.

D. Structural Performance: Provide non-load bearing metal framing capable of withstanding design loads within limits and under conditions indicated:
   1. Interior Design Wind Load: 5 lb. per sq. ft. unless otherwise indicated.
   2. Deflection Limits:
      a. Interior Partition Horizontal Deflection Limit: L/360 for rigid finishes; L/240 elsewhere.

E. Fire-Resistance Ratings: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

1.02 WALL FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 645 for conditions indicated.

B. Steel Studs (S): Punched studs of depths indicated and as follows:
   1. Flange Width: 125.
      a. Metal Thickness At Opening Jambs: As required by performance requirements and to meet loading conditions but not less than 30 mil.

C. Steel Bottom Track (T): U-shaped steel track, unpunched, with straight flanges, and as follows:
   1. Web Depth: Matching steel studs.
   2. Flange Width: 125.
D. Single Deflection Top Track (T) Option: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
   1. Web Depth: Matching steel studs while allowing free vertical stud movement.
   2. Flange Width: 1 inch plus the design gap for 1-story structures and 1 inch plus twice the design gap for multi-story structures.
   3. Metal Thickness: Not less than steel studs and designed to resist transverse loading in accordance with SSMA Technical Note 1.

E. Double Deflection Top Track (T) Option: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
   1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
      a. Web Depth: Matching steel studs.
      b. Flange Width: 1 inch plus the design gap for 1-story structures and 1 inch plus twice the design gap for other applications.
      c. Metal Thickness: Not less than steel studs and designed to resist transverse loading in accordance with SSMA Technical Note 3.
   2. Inner Track: As follows:
      a. Web Depth: Matching steel studs.
      b. Flange Width: 125.
      c. Minimum Metal Thickness: Matching steel studs.

F. Cold-Rolled Steel Channel Bridging: U-shaped steel.
   1. Depth: 1-1/2 inch.
   3. Clip Angle: Galvanized steel, prepunched, not less than 1-1/2 by 1-1/2 inches by stud web depth minus 1/4 to 1/2 inch.
      a. Minimum Metal Thickness: 54 mil.

G. Proprietary Bridging: Galvanized steel, 54 mil thickness, right-angle shaped bars, pre-notched to rigidly hold studs on 12-, 16- or 24-inch centers without supplemental fasteners.
   1. Products:
      a. TradeReady® SPAZZER®* 5400 by Clark/Dietrich Building Systems.
      b. Comparable products by other manufacturers will be considered.

H. Furring Members:
      a. Depth: 7/8 inch.

I. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Metal Thickness: 54 mil.

1.03 SUSPENSION SYSTEM COMPONENTS

A. Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper wire; mild steel rods; or mild steel flats, sized per ASTM C754 based on size of area supported.
   1. Hanger Attachments to Concrete: Fabricated from corrosion-resistant materials with holes, loops, clips, or other devices for attaching wire hangers as follows:
      a. Post-Installed Anchors: Per Div. 05 Section "POST-INSTALLED ANCHORS."

B. Carrying Channels (Main Runners): Cold-rolled U-shaped steel.
1. Depth: As indicated on Drawings or, if not indicated, as required by ASTM C754 based on size of area supported, total uniform load, and performance requirements for vertical deflection. 1-1/2 inch.

C. Furring Channels (Furring Members):
      a. Depth: 7/8 inch.
   2. Steel Studs and Runners: As specified above for wall studs.
      a. Depth: As indicated on Drawings.
      b. Minimum Metal Thickness: 30 mil.

D. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire.

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:
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.
      d. Comparable products by other manufacturers will be considered.

1.04 MATERIALS

A. Steel Sheet: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
   1. Grade: ASTM A653, SS Grade 33.

1.05 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

C. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 by an independent testing agency.
   2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 by an independent testing agency.

D. Isolation Strip: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   2. 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.
E. Gypsum Grout for Hollow Metal Frames in Drywall Construction: Setting-type compound per Div. 08 Section "GYPSUM BOARD."

F. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

G. Sound Attenuation Blankets: As specified in Division 09 Section "Acoustic Insulation."

H. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

PART 2 - EXECUTION

2.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

2.02 INSTALLATION, GENERAL

A. Installation Standard: Comply with ASTM C 754 and manufacturer's written installation instructions and recommendations.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 and GA-216 that apply to framing installation.

B. Interface with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently with a minimum 1/2-inch clearance between framing members to allow for installation of control joint in finished assembly.

2.03 WALL FRAMING INSTALLATION

A. Install tracks (runners) at floors and overhead supports.

1. Where bottom track is installed directly on slabs-on-grade, install isolation strip under track.

2. Slip-Type Head Joints: Where framing extends to overhead structural supports, install by one of the following methods to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

   a. Install single deep-leg deflection top tracks and anchor to building structure. Do not anchor studs to top deflection track.

      1) Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 to 18 inches of single deflection track.

   b. Install double deep-leg deflection top tracks, anchor studs to inner track, and anchor outer track to building structure.

   c. Install proprietary deflection top track, anchor studs to track per track manufacturer's printed instructions to allow vertical deflection movement.

   d. Install firestop top track where indicated.
A. Install studs 16 inches o.c. unless otherwise indicated, but in any case not greater than spacings required by referenced installation standards for assembly types. Install studs so flanges within framing system point in same direction.
   1. At full height partitions, extend framing full height to structural supports or substrates above suspended ceilings.
   2. Where studs are installed directly against exterior concrete or masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs 16 inches o.c. unless otherwise indicated, but in any case not greater than spacings required by referenced installation standards for assembly types. Install studs so flanges within framing system point in same direction.
   1. At full height partitions, extend framing full height to structural supports or substrates above suspended ceilings.
   2. Where studs are installed directly against exterior concrete or masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Door, Borrowed Light, and Other Openings: Install double studs at opening jambs. Continue framing above doors and above and below borrowed lights, ducts, and other openings in partitions.

D. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated. Extend partitions continuous from floor to underside of solid structure.
   1. At penetrations in fire-resistance-rated partitions, maintain fire-resistance rating of assembly by installing supplementary steel framing around perimeter of penetrations. Coordinate with Div. 07 Section "FIRESTOPPING" and install fire protection behind non-listed electrical boxes containing wiring devices, and similar items.

E. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated. Extend partitions continuous from floor to underside of solid structure.

F. Direct Furring: Install furring members at spacing indicated, but in any case not greater than spacings required by referenced installation standards for assembly types. Attach furring members to framing with screws at each intersection and to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
   1. Install hat-shaped, rigid furring channels at 16 inches o.c. perpendicular to framing and vertically on concrete and masonry.
      a. Install starter channel to provide solid support under gypsum board edges at floor line.

G. Install supplementary framing around openings and as required for blocking, bracing, and support of gravity and pullout loads of heavy trim, counters, shelving, cabinets, fixtures, handrails, wall-mounted door stops, grab bars, toilet accessories, equipment, services, furnishings, and similar items that cannot be supported directly by wall assembly framing.
   1. Coordinate with Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood blocking.
   2. Install bracing at terminations in assemblies and where indicated or required to brace assemblies.

H. Thermal Insulation: Install insulation in built-up framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Acoustical Sealant: Where indicated, seal joints between edges of framing and abutting construction with acoustical sealant.

J. Sound Attenuation Blankets: Where indicated, install blankets before installing gypsum panels unless blankets are readily installed after gypsum panels have been installed on one side.

K. 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.
2.04 SUSPENSION SYSTEM INSTALLATION

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Do not attach hangers to the following:
      a. Steel roof deck.
      b. Rolled-in hanger tabs of composite steel floor deck.
      c. Permanent metal forms.
   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 09 22 16
SECTION 09 26 13 - GYPSUM VENEER PLASTERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Gypsum veneer plaster and gypsum base for veneer plaster.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations, fabrication, and installation of control joints, reveals, and trim; include plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For the following products:
   1. Trim Accessories: Full-size sample in 6 inch length for each trim accessory.
   2. Textured Finishes: Manufacturer's standard size for each textured finish and on rigid backing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

C. Stack panels flat on leveled supports off floor or slab to prevent sagging.

1.06 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.
   2. Maintain not less than 55 deg F or more than 80 deg F for seven days before application of gypsum base and gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.
B. Avoid conditions that result in gypsum veneer plaster drying too rapidly.
   1. Distribute heat evenly; prevent concentrated or uneven heat on veneer 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 veneer plaster application until it is dry.

C. Do not install panels that are wet, moisture damaged, or mold damaged.
   3. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   4. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS
A. Source Limitations: Obtain gypsum veneer plaster products, including gypsum base for veneer plaster, joint reinforcing tape, and embedding material, from single manufacturer.

2.03 PANEL PRODUCTS
A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Gypsum Base for Veneer Plaster: ASTM C 1396/C 1396M.
   1. Products:
      a. CertainTeed Corp.; ProRoc Veneer Plaster Base.
      c. Lafarge North America Inc.; Plasterbase.
      d. National Gypsum Company; Kal-Core Regular.
      e. USG Corporation; Imperial Regular Gypsum Base.
   2. Thickness: 1/2 inch.

2.04 GYPSUM VENEER PLASTER
A. One-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster formulated for application directly over substrate without use of separate basecoat material.
   1. Products:
      a. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; PearlCote Interior Veneer Plaster.
      c. USG Corporation; Diamond Interior Finish Plaster.
2.05 JOINT REINFORCING MATERIALS

A. General: Comply with joint strength requirements in ASTM C 587 and with gypsum veneer plaster manufacturer's written recommendations for each application indicated.

B. Joint Tape:
   1. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for applications indicated.

C. Embedding Material for Joint Tape:
   1. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for use with joint-tape material and gypsum veneer plaster applications indicated.

2.06 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.

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.

2.07 TRIM ACCESSORIES

A. Standard Trim: ASTM C 1047, provided or approved by manufacturer for use in gypsum veneer plaster applications indicated.
   1. Material: Galvanized-steel sheet or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Corner bead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives veneer plaster.
      d. L-Bead: L-shaped; exposed long flange receives veneer plaster.
      e. U-Bead: J-shaped; exposed short flange does not receive veneer plaster.
      f. Control joints.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
   1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   2. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLING PANELS, GENERAL

A. Gypsum Base for Veneer Plaster: Apply according to ASTM C 844 unless manufacturer's written recommendations are more stringent.
1. Do not allow gypsum base to degrade from exposure to sunlight, as evidenced by fading of paper facing.

2. Erection Tolerance: No more than 1/16-inch offsets between planes of gypsum base panels, and 1/8 inch in 8 feet noncumulative, for level, plumb, warp, and bow.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the 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 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 locate joints, other than control joints, at corners of framed openings.

E. Attach panels to framing provided at openings and cutouts.

F. Form control joints with space between edges of adjoining panels.

G. Fastener Spacing: Comply with ASTM C 844 and manufacturer's written recommendations.
   1. Space screws a maximum of 12 inches o.c. along framing members for wall or ceiling application.

3.03 INSTALLING PANELS

A. Install panels for veneer plaster in locations indicated on Drawings.

B. Single-Layer Application:
   1. On ceilings, apply gypsum base panels before wall panels, to the greatest extent possible and at right angles to framing unless otherwise indicated.

C. Fasteners: Drive fasteners flush with gypsum base surface. Do not overdrive fasteners or cause surface depressions.

D. Single-Layer Fastening Methods: Apply gypsum base panels to supports with steel drill screws.

3.04 INSTALLING TRIM ACCESSORIES

A. General: Install trim with back flanges intended for fasteners, and attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install according to ASTM C 844 and in specific locations approved by Architect.

C. Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.
   2. LC-Bead: Use at exposed panel edges.
   3. L-Bead: Use where indicated.
   4. U-Bead: Use where indicated.
3.05 INSTALLING JOINT REINFORCEMENT

   A. Gypsum Base: Reinforce interior angles and flat joints with joint tape and embedding material to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

3.06 GYPSUM VENEER PLASTERING

   A. Gypsum Veneer Plaster Mixing: Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

   B. Gypsum Veneer Plaster Application: Comply with ASTM C 843 and with veneer plaster manufacturer's written recommendations.

      1. One-Component Gypsum Veneer Plaster: Trowel apply base coat over substrate to uniform thickness. Fill all voids and imperfections. Immediately double back with same mixer batch of plaster to a uniform total thickness of 1/16 to 3/32 inch.

      2. Where gypsum veneer plaster abuts metal door frames, windows, and other units, groove finish coat to eliminate spalling.

      3. Do not apply veneer plaster to gypsum base if paper facing has degraded from exposure to sunlight. Before applying veneer plaster, use remedial methods to restore bonding capability to degraded paper facing according to manufacturer's written recommendations and as approved by Architect.

   C. Gypsum Veneer Plaster Finish: Match existing.

3.07 PROTECTION

   A. Protect installed gypsum veneer plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.

   B. Remove and replace gypsum veneer plaster and gypsum base panels that are wet, moisture damaged, or mold damaged.

      1. Indications that gypsum base panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.

      2. Indications that gypsum base panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 26 13
SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Gypsum wallboard for use on interior walls, ceilings, or partitions.
   2. Gypsum backing board and coreboard, designed for use as a base in interior multilayer systems.
   3. Water-resistant gypsum tile backing board as a base for the application of tile on interior walls.
   4. Gypsum shaftliner board for use in interior shaft wall assemblies.
   5. Gypsum ceiling board for use on interior ceilings and soffits.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "SHEATHING" for gypsum sheathing for exterior walls.
   4. Div. 09 Section "NON-LOAD-BEARING STEEL FRAMING" for non-structural framing and suspension systems that support gypsum board.
   5. Div. 09 Section "GYPSUM PLASTERING" for gypsum lath for plaster finishes.
   6. Div. 09 Section "ACOUSTIC INSULATION" for sound attenuation blankets installed in assemblies that incorporate gypsum board.
   7. Div. 09 Section "PAINTING" for primers applied to gypsum board surfaces.

1.02 REFERENCES

A. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   3. Gypsum Association (GA):
      c. GA-220: Gypsum Board Winter Related Installation Recommendations.
      d. GA-234: Control Joints For Fire-Resistance Rated Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."
1.05 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.06 INFORMATIONAL SUBMITTALS
   A. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

1.07 QUALITY ASSURANCE
   B. Field Samples: Per Div. 01 Section "FIELD SAMPLES" and as follows:
      1. Install samples for the following:
         a. Each level of gypsum board finish indicated for use in exposed locations.
      2. Size:
         a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
      3. Apply or install final decoration indicated, including painting, on exposed surfaces for review of samples.
      4. Simulate finished lighting conditions for review of samples.
      5. Approved samples may become part of the completed Work if undisturbed at time of Substantial Completion.

1.03 DELIVERY, STORAGE AND HANDLING
   A. Per Div. 01 Section "PRODUCT REQUIREMENTS and as follows:
      B. 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 boards flat and supported on risers on a flat platform to prevent sagging.

1.04 FIELD CONDITIONS
   A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
      B. Environmental Limitations: Comply with ASTM C840 and GA-216 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent. Comply with GA-220-2016 recommendations when installing gypsum board in cold and/or damp weather conditions.
      C. Do not install paper-faced gypsum board until installation areas are enclosed and conditioned.
      D. Do not install boards that are wet, those that are moisture damaged, and those that are mold damaged.
         1. Indications that boards are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
         2. Indications that boards are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
   A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

09 29 00 - 2
GYPSUM BOARD
B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Manufacturers:
   1. American Gypsum Company LLC.
   2. CertainTeed Gypsum, Inc.
   3. Continental Building Products Operating Company, LLC
   4. Georgia-Pacific Gypsum LLC.
   6. PABCO Gypsum, a division of PABCO® building products, LLC.
   8. Comparable products by other manufacturers will be considered, unless otherwise indicated.

2.03 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. Acoustical Performance Requirements:
   1. For sound-improved assemblies, provide materials and construction indicated.
   2. Sound-Transmission Requirements: For STC-rated assemblies, provide materials and construction identical to those tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the following:
      a. Wall and Partition Assemblies: STC Rating: As indicated.

2.04 GYPSUM BOARD, GENERAL

A. Board Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Long Edge Treatment: Tapered or tapered and featured (rounded or beveled) for prefilling.

2.05 PAPER-FACED INTERIOR GYPSUM BOARD

A. Paper-Faced Gypsum Board, General: Per ASTM C1396/C 1396M.

B. Gypsum Wallboard: Gypsum core with paper facing laminated to both sides. Specially formulated lighter weight panels may be used at Contractor's option.
   1. Fire-Retardant Type X Board Thickness: 5/8 inch.
   2. Fire-Retardant Type C Board Thickness: As required by fire-resistance-rated assembly indicated.
   3. Ceiling Board: Specially designed 1/2 inch thick board for ceilings with extra sag-resistance,

C. Mold-Resistant Gypsum Wallboard: Specially designed with mold-resistant core and paper surfaces with a rating of 10 per ASTM D3273.
   1. Fire-Retardant Type X Board Thickness: 5/8 inch, unless otherwise indicated.
D. Factory Skim-Coated Gypsum Wallboard: Manufactured with a factory-applied skim coat to achieve Level 5 finish.
   1. Fire-Retardant Type X Board Thickness: 5/8 inch, unless otherwise indicated.
   2. Products:
      a. Rapid Deco Level 5 by Continental Building Products.
      b. Comparable products by other manufacturers will be considered.

E. Abuse- and Impact-Resistant Gypsum Wallboard: Mold-resistant, specially designed to withstand abrasion, indentation, and impact.
   1. Fire-Retardant Type X Board Thickness: 5/8 inch, unless otherwise indicated.
   2. Surface Abrasion Resistance: Class 2; not greater than 0.059 inch depth when tested at 50 cycles in accordance with ASTM D4977, Modified.
   3. Surface Indentation Resistance: Class 1; not greater than 0.150 inch depth when tested in accordance with ASTM D5420.
   4. Soft Body Impact Resistance: Class 3; not less than 300 ft.-lbs. when tested in accordance with ASTM E695.
   5. Hard Body Impact/Penetration Resistance: Class 3; not less than 150 ft.-lbs. when tested in accordance with Annex A1.
   6. Products:
      a. Protecta HIR 300 by Continental Building Products.
      b. Gold Bond Hi-Impact XP by National Gypsum Company.
      c. Mold Tough VHI by United States Gypsum Company.
      d. Comparable products by other manufacturers will be considered.

F. Gypsum Shaft Liner Board: Manufacturer's proprietary fire-resistive liner boards; long edges double beveled.
   1. Fire-Retardant Type X Board Thickness: 1 inch.
   2. Mold-Resistant, Fire-Retardant Type X: 1 inch thick, with mold-resistant core and paper surfaces with a rating of 10 per ASTM D3273.

2.06 GLASS-MAT-FACED INTERIOR GYPSUM BOARD

A. Glass-Mat-Faced Gypsum Board, General: Per ASTM C1658/C 1658M, unless otherwise indicated.

B. Coated, Glass-Mat-Faced ,Gypsum Tile Backing Board: ASTM C1178/C 1178M, Specially designed with water-resistant, mold-resistant core with factory-coated fiberglass mat facing laminated to both sides and with a rating of 10 per ASTM D3273, with manufacturer's standard edges.
   1. Regular Type Board Thickness: 1/2 inch.
   2. Fire-Retardant Type X Board Thickness: 5/8 inch, unless otherwise indicated.
   3. Products:
      a. GlasRoc Tile Backer by CertainTeed Gypsum, Inc.
      b. DensShield Tile Backer by Georgia-Pacific Gypsum LLC.
      c. Gold Bond e"XP Tile Backer by National Gypsum Company.

2.07 JOINT TREATMENT MATERIALS

A. General: Per ASTM C475/C 475M.

B. Interior Joint Tape:
   1. For Paper-Faced Gypsum Board: Paper.

C. Interior Joint Compound: For each coat use formulation that is compatible with other compounds applied for previous or successive coats.
1. For Paper-Faced Gypsum Board: Where choice of drying- or setting-type compounds are specified as Contractor option, do not mix the two unless specifically permitted by the joint compound manufacturer.
   a. Prefilling: Use setting-type taping compound at joint gaps greater than 1/8 inch and damaged surface areas.
   b. Embedding and First Coat: Use setting-type taping or drying-type, all-purpose compound for embedding tape and first coat on joints, fasteners, and trim flanges.
   c. Fill Coat: Use drying-type, all-purpose or setting-type, sandable topping compound for second coat.
   d. Finish Coat: Use drying-type, all-purpose or setting-type, sandable topping compound for third coat.
   e. Skim Coat: Use one of the following for final coat of Level 5 finish:
      1) Setting-type, sandable topping compound.
      2) High-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish:
         a) Level V Wall and Ceiling Primer/Surfacer by CertainTeed Gypsum, Inc.
         b) Spray Plast - Wall Surfacer by TWI Products.
         c) Sheetrock® Brand Tuff-Hide™ Primer-Surfacer by United States Gypsum Company.
         d) Comparable products by other manufacturers will be considered.
   3) At factory skim-coated board use Continental Building Products Rapid Deco Level 5 Joint Compound.

2.08 TRIM ACCESSORIES

   1. Interior Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. L-Bead: L-shaped; exposed long flange receives joint compound.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      e. Expansion (Control) Joint: One-piece with V-shaped slot and removable strip covering slot opening.

B. High-Impact Interior Trim Accessories for Abuse- and Impact-Resistant Gypsum Board: Copolymer tapered plastic trim with paper face and joint tape backing. Engineer trim for fully bonded adhesive application with joint compound and without mechanical fasteners.
      a. Substitutions: Not permitted.
   2. Shapes:
      a. Outside Corner Trim: UltraTrim® Outside 90, Ultraflex® 325, or Ultraflex 450.
      b. Off Angle Corner Trim: Ultraflex® 325, Ultraflex 450, or Zooma-Flex.
      c. Inside Corner Trim: UltraTrim® Inside 90, Ultraflex® 325, or Zooma-Flex.
      d. L-Trim: UltraTrim® L Trim sized to fit board thickness.
      e. Corner and Transition Caps: To suit condition.

2.09 ACCESSORIES

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: Use screws complying with the following:

09 29 00 - 5
GYPSCUM BOARD
1. For steel framing less than 30 mils (0.030 inch) thickness: ASTM C1002.
2. For steel framing greater than 33 mils (0.033 inch) thickness: ASTM C954.

C. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum board to continuous substrate.

D. Adhesives for Gluing Gypsum Board to Substrates: Formulation complying with ASTM D3498 or ASTM C557 that is approved for use indicated by gypsum board and adhesive manufacturer.

E. Thermal Insulation: As specified in Div. 07 Section "THERMAL INSULATION."

F. Acoustical Joint Sealant: As specified in Div. 07 Section "JOINT SEALANTS."

G. Sound Attenuation Blankets: Insulation: As specified in Div. 09 Section "ACOUSTIC INSULATION."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

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

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

3.02 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Comply with the more stringent requirements of ASTM C840 and GA-216 and manufacturer's written installation instructions. Refer contradictions and discrepancies to Architect for resolution. Where this Specification is more stringent than the referenced standards, this Specification shall govern.

B. Do not place tapered edges against cut edges or ends.

C. Where boards of different thickness abut in same plane, shim surfaces to produce a uniform plane across board surfaces.

D. Cover both faces of support framing with gypsum board in concealed spaces (above ceilings, etc.), except inside chases.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished using scraps not less than 8 sq. ft. in area.

E. Isolate perimeter of gypsum board applied to non-load-bearing partitions at penetrating structural members and abutments other than floors. Cut gypsum board to fit profile of structural members leaving 1/4- to 1/2-inch-wide gaps between board edges and structural members. Trim edges with edge trim in exposed locations. Seal gaps with acoustical sealant. Maintain continuity of fire-rated construction.

F. STC-Rated and Sound-Improved Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and
closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
1. Install sound attenuation blankets before installing gypsum board, unless blankets are readily installed after boards have been installed on one side.

G. At hollow metal frames, spot grout at anchor clips on hollow frame jambs. Fill inside face profile of frame at each jamb anchor with setting type joint compound and bevel back to edge of frame stop. Immediately insert gypsum board into the jamb and attach to framing.

3.03 APPLYING GYPSUM BOARD

A. Single-Layer Gypsum Board Application:
1. On ceilings, install boards perpendicular to framing. When possible, avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent boards not less than one framing member.
2. On partitions/walls, apply gypsum boards with long dimension vertical (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly. Install in lengths to minimize end joints.
   a. At stairwells and other high walls, install boards horizontal (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly.
3. On furring members, apply gypsum board parallel to framing in lengths to minimize end joints. Locate edge joints over furring members.

B. Multilayer Gypsum Board Application:
1. On ceilings, apply base layers before applying base layers on walls/partitions; apply face layers in same sequence.
2. Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners, unless otherwise indicated or required by fire-resistance-rated assembly.

C. Gluing to Substrates: Where gypsum board is indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum board until fastening adhesive has set.

D. Shaft-Wall Assemblies: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
1. See Div. 09 Section "NON-STRUCTURAL METAL FRAMING" for installing steel framing.
2. Seal gypsum board at perimeter of each assembly with acoustical sealant where abutting other work and at joints and penetrations within each assembly.
   a. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C919 requirements or with manufacturer's written instructions, whichever are more stringent.

3.04 INSTALLING TRIM ACCESSORIES

A. Trim Types: Install standard trim, unless otherwise indicated. Install high-impact trim with high impact resistance where abuse- and impact-resistant gypsum board is indicated.
1. Standard Trim: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for boards. Otherwise, attach trim according to manufacturer's written instructions.
2. High-Impact Trim: Install in full bed of drying-type all-purpose or taping joint compound without mechanical fasteners according to manufacturer's written instructions. Sand after final coat.
B. Trim Shapes: Install in the following locations where finish Levels 3, 4, and 5 are specified:
1. Cornerbead: Use at outside corners, unless otherwise indicated.
2. LC-Bead: Use at exposed board edges.
3. L-Beck: Use at exposed vertical board edges where LC-Bead cannot be used.
4. U-Beck: Use at exposed board edges in non-visible locations and where indicated.
5. Arch Cornerbead: Use at curved openings.

C. Control Joints: Install where indicated on Drawings and as follows. If joint locations are not indicated, obtain Architect's approval for visual effect.
1. Install where partitions, walls, or ceilings traverse construction joints (expansion, seismic, or building control element) in the base building structure.
2. Install where partitions of dissimilar construction meet and remain in the same plane.
3. At walls with uninterrupted straight planes, install so linear dimensions between control joints in do not exceed 30 feet.
   a. Floor to ceiling height door frames will be considered equivalent to a control joint.
4. At interior ceilings with perimeter relief, install so linear dimensions between control joints do not exceed 50 feet and total area between control joints does not exceed 2500 square feet.
5. At interior ceilings without perimeter relief, install so linear dimensions between control joints do not exceed 30 feet and total area between control joints does not exceed 900 square feet.
6. Install where ceiling framing members change direction.
7. Install where wings of "L", "U", and "T" shaped ceiling areas join.
8. Where control joints occur in acoustical and fire-rated systems, provide blocking behind control joints using backing material such as 5/8 inch Type X gypsum board, mineral fiber, or other tested equivalent. Comply with GA-600 or GA-234.

3.05 FINISHING GYPSUM BOARD

A. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

B. Sanding: Use dry- or wet-sanding method at Contractor's option:
1. Wet-sand to smooth joint treatment materials and to remove excess joint compound from lap marks, tool marks, crowned joints, and filled blemishes. Vacuum sanding residue promptly from gypsum board and surrounding surfaces.
   a. Use a high-density, small-celled polyurethane sponge resembling high-quality carpet padding. For touch-up use a general purpose sponge or smooth, soft cloth.
   b. Saturate the sponge with clean, cool to lukewarm (not hot) water containing no soap or additives. Wring out sponge only enough to eliminate dripping.
   c. To remove high spots, gently rub joints in a direction parallel to the joint compound surface; do not rub down into the joint compound.
   d. Use as few strokes as possible to avoid grooving joints.
   e. Clean sponge frequently.
   f. Allow wet sanded areas to dry thoroughly between application of additional coats of joint compound and before decorating.

C. Interior Gypsum Board Finish Levels: Finish boards to levels indicated below per ASTM C840 and GA-214:
1. Level 0: Concealed areas above ceilings, unless a higher level of finish is required for fire-resistance- or sound-rated assemblies.
2. Level 1: Concealed surfaces as follows whether or not accessible in finished Work.
   a. Fire-resistance-rated assemblies.
   b. Sound-rated assemblies.
3. Level 2: Surfaces as follows where not visible in finished Work.
a. Hard (ceramic, stone, or glass) tile substrates.
b. Utility areas.
c. Unpainted areas.
d. Behind cabinetry.

4. Level 3: Surfaces as follows where lighting conditions are not critical.
a. Heavy wall covering substrates.

5. Level 4: Surfaces as follows where exposed to view where lighting conditions are not critical, unless otherwise indicated.
a. Surfaces receiving flat, velvet, eggshell, and satin paint finish.
b. Medium or light wall covering substrates.
c. Heavy wall covering substrates where lighting conditions are critical.

6. Level 5: Surfaces as follows where exposed to view where lighting conditions are critical as defined in GA-214.
a. Surfaces receiving semi-gloss and gloss paint finish.
b. Surfaces where lighting conditions are critical.
c. Where indicated on Drawings.

D. Tile Backing Board Finishing: Finish according to board manufacturer's written instructions.

3.06 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. 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.

C. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

D. Remove and replace boards that are wet, moisture damaged, and mold damaged.
   1. Indications that boards are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that boards are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.07 SCHEDULE OF GYPSUM BOARD TYPES AND USE LOCATIONS

A. Paper-Faced Interior Gypsum Board: Install in the following locations not subject to wetting during construction:
   1. Fire-Retardant Type X Gypsum Wallboard: Vertical surfaces, unless otherwise indicated.
   2. Fire-Retardant Type C Gypsum Wallboard: Where required for specific fire-resistance-rated assembly indicated.
   3. Ceiling Board: Ceiling surfaces.
   4. Moisture- and Mold-Resistant Gypsum Board: At surfaces subject to wetting during construction, on walls with plumbing fixtures where not covered with tile, and elsewhere as indicated. Install Type X where indicated and where required for fire-resistance-rated assemblies.
   5. Factory Skim-Coated Gypsum Wallboard: Where Level 5 finish is required as an option to skim-coating standard board. Install Type X where indicated and where required for fire-resistance-rated assemblies.
   7. Fire-Retardant Type X Shaft Liner Board: At shaft-walls not subject to wetting during construction.
8. Mold-Resistant, Fire-Retardant Type X Shaft Liner Board: At shaft-wall surfaces subject to wetting during construction and elsewhere as indicated.

END OF SECTION 09 29 00
SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes tiling on interior walls and floors.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 07 Section "JOINT SEALANTS" for sealing of movement joints in tile surfaces.
   4. Div. 09 Section "GYPSUM BOARD" for glass-mat, water-resistant gypsum backing boards.

1.02 REFERENCES

A. Definitions:
   1. Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
   2. Large and Heavy Tile (LHT): Tile with any dimension larger than 15 inches and/or weighing more than 5 pounds/square foot.

B. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Maintain on site a copy of the following standards affecting the Work of this Section.
   3. Tile Council of North America (TCNA):

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" prior to installation of floor and wall substrates indicated to receive tile.
   1. Review requirements in ANSI A108.01, TCNA Handbook, including tolerances for substrates and preparation by other trades.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces.
C. **Samples**:
   For each type and composition of tile and grout, and for each color and finish of tile, grout, and accessories required.
   1. **Samples for Initial Selection**:
      Tile, grout, and accessories involving color selection.
   2. **Samples for Verification**:
      a. **Tile Units**:
         Full-size units.
      b. **Trim and Accessory Items**:
         Full-size units.
      c. **Stone Thresholds**:
         6-inch lengths.
      d. **Metal Edge and Transition Strips**:
         6-inch lengths.

### 1.06 INFORMATIONAL SUBMITTALS

**B. Certificates**:
Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product certificates for each type of product.
   2. Master Grade Certificates for each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

**C. Product Test Reports**:
   1. For tile-setting and -grouting products.
   2. For certified porcelain tile.
   3. For wet and dry, dynamic and static coefficient of friction for floor tiles.

### 1.06 QUALITY ASSURANCE

**A. Qualifications**:
Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. **Installer Qualifications**:
      Minimum 5 years experience under current organizational structure.
      a. **Company**:
         Five-star member of the National Tile Contractors Association (NTCA) or Trowel of Excellence member of the Tile Contractors’ Association of America (TCAA).
      b. **Project Experience**:
         Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
      c. **Staff**:
         1) **Foreman**:
            Employ a competent foreman to supervise Work of this Section. Foreman shall hold the International Masonry Institute’s Foreman Certification and be present whenever Work is in progress.
         2) **Installers**:
            Employ installers holding the following credentials or meeting the requirements of a program approved by the Architect with criteria for such program similar to or exceeding:
            a) **Ceramic Tile Education Foundation (CTEF) Certified Installer**.
            b) **Recognized by the U.S. Department of Labor as Journeyman Tile Layers**.
            c) **Advanced Certification for Tile Installers (ACT) Certified for Large Format Tile and Substrate Preparation, and Grouts**.

### 1.07 DELIVERY, STORAGE, AND HANDLING

**A. Per Div. 01 Section "PRODUCT REQUIREMENTS"** and as follows:
   1. Comply with requirements in ANSI A137.1 for labeling tile packages.

### 1.08 FIELD CONDITIONS

**A. Ambient Conditions**:
Per Div. 01 Section "EXECUTION" and as follows:
   1. Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer’s written instructions.
PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Project Source Limitations:
   1. Tile: Obtain tile of each type and color or finish from single source or producer and from same production run and of consistent quality in appearance and physical properties for each contiguous area.
   2. Other Products: Obtain secondary and incidental components including setting materials and accessories from a single manufacturer for each product acceptable to tile manufacturer.
      a. Obtain setting and grouting material ingredients of a uniform quality for each mortar and grout component.
      b. Obtain each aggregate from single source or producer.

2.03 DESCRIPTION

A. Tiling consists of providing tile, setting materials and accessories of types and sizes indicated for installation on interior walls and floors.

2.04 PERFORMANCE CRITERIA

A. Dynamic Coefficient of Friction (DCOF): For tile installed on level, interior walkway surfaces expected to be walked upon when wet, provide products with DCOF of not less than 0.42 as determined by testing identical products per method specified in paragraph 9.6 of ANSI A137.1.

2.05 PRODUCTS, GENERAL

A. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.06 CERAMIC TILE PRODUCTS

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements, unless otherwise indicated.

B. Products:
   2. Comparable products by other manufacturers will be considered.
2.07 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product complying with ANSI A118.12; recommended by manufacturer for application indicated; complete with reinforcement and accessories recommended by manufacturer.

   1. Basis-of-Design Product: Blue 92 Anti-Fracture Membrane by Laticrete International, Inc. or a comparable product by one of the following:
      a. Bostik, Inc.
      b. Custom Building Products.
      c. MAPEI Corp.
      d. TEC; a subsidiary of H. B. Fuller Company.
      e. Comparable products by other manufacturers will be considered.

2.08 SETTING MATERIALS

A. Manufacturers:
   1. Bostik, Inc.
   2. Custom Building Products.
   3. Laticrete International, Inc.
   4. MAPEI Corp.
   5. TEC; a subsidiary of H. B. Fuller Company.

B. Thin-Set Mortar:
   1. Mortar, General: Provide factory-prepared mixture of Portland cement, sand, and additives.
      a. For wall applications, provide nonsagging (T) type mortar.
      b. For large and heavy tile (LHT), provide mortar intended to be used as a bond coat 3/32 to 1/2 inch thick after tile is embedded.
   2. Improved Modified Dry-Set Mortar: ANSI A118.15; with special latex/polymer additive in redispersible latex/polymer powder form, to which only water is added at Project site.

C. Grout:
   1. General:
      a. Provide unsanded grout mixture for joints 1/8 inch and narrower. Provide sanded grout mixture for joints wider than 1/8 inch.
      b. Grout Colors: As indicated or, if not indicated, as selected from manufacturer's full range.
   2. High-Performance Grout: ANSI A118.7; factory-prepared mixture of cement, sand, and other ingredients with redispersible latex/polymer powder, to which only water is added at Project site.

2.09 TILE TERMINATION ACCESSORIES

A. Metal Edge Strips: Metal strips with integral perforated anchoring leg for anchorage to mortar bed or substrate; height to match tile and setting bed thickness.
   1. Basis of Design Manufacturer: Schlüter Systems or comparable products by one of the following:
      b. Ceramic Tool Company, Inc.
      c. National Metal Shapes, Inc. Aluminum L-Shape Profiles.
2.10 MISCELLANEOUS MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex/polymer-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Sealant: Provide sealant compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."
   1. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.11 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and per Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

B. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile comply with ANSI A108.01 requirements.
   2. Verify that installation of anchors, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Concrete Floors: Fill cracks, holes, and depressions for floor tile installed with thin-set mortar with trowelable leveling and patching compound.

D. Concrete and Masonry Walls: Mechanically scarify sound, crack-free walls for direct-applied mortar and tile to remove dust, form-release compounds, paint, efflorescence, and loose material and rough-up smooth surfaces.

E. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, blend tiles at Project site before installing.
3.02 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane in the following locations to comply with ANSI A108.17 and manufacturer’s written instructions to produce membrane of uniform thickness and bonded securely to substrate.

1. Partial coverage per TCNA Method F125-Partial over unintended existing substrate cracks, including hairline and spider-web cracks. See Movement Joints in Concrete paragraph below for formed, sawed, and cold joint crack locations. Omit crack isolation membrane in areas indicated to receive waterproof membrane.
   a. Install over cracks and joints in width equal to not less than 2 times the largest overlain tile dimension centered over cracks and joints.
   b. Extend membrane at least halfway under adjacent tiles which do not occur over the crack or joint.
   c. In no case shall crack-suppression membrane terminate on or in line with the edge of tiles set over cracks and joints.
   d. On both sides of each crack, install sealant in soft joints located in grout joints nearest cracks.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.03 TILE INSTALLATION

A. Comply with TCNA’s "Handbook for Ceramic Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series “Specifications for Installation of Ceramic Tile” that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
   a. Under thresholds.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer’s standard trim shapes where necessary to eliminate exposed tile edges.

E. Where adjacent tiles differ in thickness, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay out tile work as follows, unless otherwise indicated:

1. Lay tile in grid pattern.
2. Center tile fields in both directions in each space or on each wall area.
3. Minimize use of pieces that are less than half of a tile.
4. Provide uniform joint widths.
5. Where adjoining tiles on floor, base, walls, or trim are same size, align joints.
6. Where tiles are whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints.
7. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
G. Joint Widths: Install tile with joint widths not less than three times the actual variation in tile facial dimension. If narrower joint widths are indicated, consult with Architect for resolution of discrepancy.

H. Allowable Lippage for Installed Tile: Unless otherwise indicated, install tile with the following maximum lippage:

<table>
<thead>
<tr>
<th>TILE TYPE</th>
<th>TILE SIZE (INCH)</th>
<th>JOINT WIDTH (INCH)</th>
<th>ALLOWABLE LIPPAGE (INCH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mosaic / Glazed Wall</td>
<td>1 x 1 to 6 x 6</td>
<td>1/16 to 1/8</td>
<td>1/32</td>
</tr>
<tr>
<td>Quarry</td>
<td>6 x 6 to 8 x 8</td>
<td>1/4 or greater</td>
<td>1/16</td>
</tr>
<tr>
<td>Porcelain and Pressed Floor Tiles</td>
<td>All</td>
<td>1/16 to less than 1/4</td>
<td>1/32</td>
</tr>
<tr>
<td>Porcelain and Pressed Floor Tiles</td>
<td>All</td>
<td>1/4 or greater</td>
<td>1/16</td>
</tr>
</tbody>
</table>

I. Lay out tile wainscots to dimensions indicated.

J. For mosaic tile, where wainscot height indicated requires cutting tiles, extend wainscot to next full tile beyond dimensions indicated.

K. Movement Joints in Concrete: Provide movement joints and other sealant-filled joints where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Locate movement joints at locations indicated on Drawings and according to TCNA guidelines. Where locations are not indicated, locate movement joints as approved by Architect for visual effect and as follows:
      a. Where floors and walls meet and at interior wall corners.
      b. Tile edge terminations without metal edge strips.
      c. Where tile work abuts restraining surfaces such as perimeter walls, dissimilar floors, thresholds, curbs, columns, pipes, ceilings, and where changes occur in backing materials. Do not install movement joints at drain strainers.
      d. Directly above saw-cut, control, contraction, construction, and isolation joints in concrete substrates.
   2. In addition to the above locations, provide movement joints as follows:
      a. Interior Tile:
         1) For areas where temperature variations do not exceed 20 degree F, space movement joints 20 to 25 feet o.c. in each direction.
         2) For areas exposed to direct sunlight or moisture, space movement joints 8 to 12 feet o.c. in each direction.
         3) Size floor joints over concrete saw-cuts not less than width of saw cut.
         4) Size joints over structural expansion joints not less than width of structural joint.
         5) Size joints in mosaic and glazed wall tile to match grout joints, but not less than 1/4 inch.
         6) Size joints in other tile to match grout joints, but not less than 1/4 inch.

L. Sealant: Prepare movement joints and other sealant-filled joints and install sealants per Div. 07 Section "JOINT SEALANTS."

3.04 TILE TERMINATION ACCESSORY INSTALLATION

A. Stone Thresholds: Install thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
1. Do not extend crack isolation membrane under thresholds.

B. **Metal Edge Strips**: Install at the following locations and as indicated on Drawings:
   1. Install floor edge strip where exposed edge of tile flooring meets adjacent flooring that finishes flush with or less than 1/4 inch below top of tile and no threshold is indicated.
   2. Install outside corner strip at vertical and horizontal external corners where tilework wraps corners.
   3. Install edge termination strip where tile terminates at top of wainscot at vertical edges other than inside corners.

3.05 **ADJUSTING**

A. Per Div. 01 Section "EXECUTION."

B. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

3.06 **CLEANING**

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. On completion of placement and grouting, clean ceramic tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.07 **PROTECTION**

A. Per Div. 01 Section "EXECUTION."

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit traffic from tiled floors for at least 72 hours after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.08 **ATTACHMENTS**

A. See Tiling Schedule for a list of installation methods, acceptable products, and areas of application.

B. See Finish Material Schedule on Drawings for manufacturer's designations for tile size and color selections.
END OF SECTION 09 30 00

09 30 00 - 9
TILING
## TILING SCHEDULE

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SUBSTRATE</th>
<th>SURFACE / CONDITION</th>
<th>EXPOSURE</th>
<th>2015 TCNA METHOD</th>
<th>SETTING METHOD</th>
<th>TILE</th>
<th>GROUT</th>
<th>BOND COAT</th>
<th>MEMBRANE</th>
<th>UNDERLAMENT OR BACKER BOARD</th>
<th>LOCATION</th>
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<tbody>
<tr>
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<td>Floor, on-grade</td>
<td>COM3</td>
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<td>Thin-set</td>
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<td>ANSI A118.7</td>
<td>ANSI A118.15</td>
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<td>COM1</td>
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**Notes:**
- **TCNA:** Tile Council of North America
- **ANSI:** American National Standards Institute
- **W.R.:** Water Resistant
- **Gyp Bd:** Gypsum Board
- **Thin-set:** Thin-set method
- **Thick-set:** Thick-set method
- **EJ171:** Expansion Joint; general
- **Div 07 Section "Joint Sealers":** Expansion Joint; general; seal joints per Div 07 Section "Joint Sealers"
- **Saw-Cut; Cold Joint:** Saw-Cut; Cold Joint
- **Contraction Joint:** Contraction Joint
- **Expansion Joint:** Expansion Joint
- **Isolation/Expansion Joint:** Isolation/Expansion Joint
- **Perimeter Joint:** Perimeter Joint
- **Expansion Joint; Bonded Areas:** Expansion Joint; Bonded Areas
- **Generic Joint:** Generic Joint
- **Perimeter Joint:** Perimeter Joint
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END OF SCHEDULE 09 30 00.13

C:\Dropbox (ABA)\Specifications Projects\2023\2022\614 DPSDD PS104 Spec\2022-06-09_90% & 06-16 100%\09 30 00.13_wsx tiling schedule.xlsx\SCHEDULE
SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Coordinate Work of this Section with Facility Services Subgroup Sections (Div. 20-29) for locations of services incorporated in or penetrating ceiling.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, showing the following items coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Perimeter moldings.
   3. Structural members to which suspension systems will be attached.
   4. Items penetrating finished ceiling including, but not limited to, the following:
      a. Fire protection sprinkler heads.
      b. HVAC outlets and inlets.
      c. Lighting fixtures and electrical devices.
      d. Speakers.

C. Samples: For each type, color, pattern, and texture of exposed products for verification.
   1. Sample Size:
      a. 6 inch square for panels.
      b. 6 inches in length for suspension grid members.

1.05 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports: As follows:
   1. Product test reports for each type acoustical ceiling panel.
   2. Research reports for each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
1.06 CLOSEOUT SUBMITTALS
   A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

1.07 "CLOSEOUT PROCEDURES" DELIVERY, STORAGE, AND HANDLING
   A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
      1. Deliver products in original, unopened packages.
      2. Store products in a fully enclosed, conditioned space, protected against damage from
         moisture, humidity, temperature extremes, direct sunlight, surface contamination, and
         other causes.
      2. Before installing acoustical panels, permit them to reach room temperature and a
         stabilized moisture content.
      3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.05 FIELD CONDITIONS
   A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
      1. Do not deliver or install acoustical panel ceilings until building is enclosed, wet work is
         complete, and HVAC system is operating and will maintain temperature and relative
         humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
   A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to
      products.

   B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting
      Products and procedures for offering comparable products.

2.02 PERFORMANCE REQUIREMENTS
   A. Surface-Burning Characteristics: ASTM E 1264; Class B when tested per ASTM E84.

2.03 ACOUSTICAL PANELS
   A. Acoustical Panel Products: As indicated by manufacturer’s designations in the Finish Material
      Schedule.
      1. Classification: Provide manufacturer’s standard panels complying with ASTM E 1264.
      2. Colors, Patterns, and Modular Size: As indicated.
      3. Edge/Joint Detail: As indicated.

   B. 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 per ASTM D 3273 and evaluated per ASTM D 3274 or
      ASTM G 21.

2.04 SUSPENSION SYSTEM
   A. Manufacturers:
      1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. Chicago Metallic Corporation.
4. USG Interiors, Inc.; Subsidiary of USG Corporation.
5. Comparable products by other manufacturers will be considered.

B. 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.

C. Suspension System: As indicated by manufacturer’s designations in the Finish Material Schedule.

D. Edge Moldings: Manufacturer’s standard moldings for edges and penetrations, formed from same material, finish, and color as suspension-system runners.
   1. For square-edged panels, provide standard L-shaped moldings that match width of exposed runners for mounting at same elevation as face of runners.
   2. For reveal-edged panels, provide standard L-shaped moldings for mounting at same elevation as face of grid.
   3. For circular penetrations of ceiling, provide matching edge moldings fabricated to diameter required to fit penetration.

E. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.
   1. Expansion anchors of material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable.
   2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190.

F. Hangers, Braces, and Ties:
   1. Wire Hangers:
      b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106 inch diameter wire.

2.05 ACCESSORIES

A. Hold-Down Clips: Where indicated, provide manufacturer’s standard hold-down clips spaced 24 inches o.c. on all cross tees.

B. Impact Clips: Where indicated, provide manufacturer’s standard impact-clip system designed to absorb impact forces against acoustical panels.

C. Acoustical Insulation: Per Div. 09 Section “ACOUSTIC INSULATION.”
PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
1. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
2. Locate system on room axis according to reflected ceiling plans.
3. Verify major above-ceiling work is complete. Layout hangers to avoid interfering with other above-ceiling work.

3.02 SUSPENSION SYSTEM INSTALLATION

A. Install suspension system per ASTM C 636/C 636M manufacturer's written instructions, and as specified herein.

B. Suspend ceiling hangers from building's structural members as follows:
1. Attach hangers to structural members or to post-installed anchors or power-actuated fasteners that extend through permanent metal forms or floor deck into concrete.
   a. Do not support ceilings directly from permanent metal forms or floor deck.
   b. Do not attach hangers to steel deck tabs.
   c. Do not attach hangers to steel roof deck.
2. Install carrying channels or other supplemental support, designed to support imposed loads, for attachment of hanger wires in the following locations:
   a. Where spacing of structural members does not permit installation of hanger wires at spacing required.
   b. Where ductwork, equipment, and other non-structural items within ceiling plenum interfere with hanger spacing.

C. Install edge moldings of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. 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.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

3.03 CEILING PANEL INSTALLATION

A. Install acoustical panels per manufacturer's instructions, 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. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For reveal-edged panels, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Arrange directionally patterned acoustical panels as directed.

B. Cut acoustical panels where required to fit irregular grid and perimeter edge trim.
1. Make field cut edges of same profile as factory edges.
2. Double cut and field paint exposed reveal edges to match factory edges using coating recommended in writing for this purpose by acoustical panel manufacturer.
3.04 ACCESSORY INSTALLATION

A. Install hold-down or impact clips in areas indicated, in areas required by authorities having jurisdiction; space as recommended by panel manufacturer's written instructions unless otherwise indicated.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members.
   2. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
   3. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13
SECTION 09 54 23.13 - METAL CEILING ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY
   A. Section includes suspended linear bar metal ceiling system.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meetings: Conduct at Project site.
   B. Coordination: Coordinate with fire suppression, HVAC, electrical, and other work as required to accommodate those systems and prevent interferences with required clearances.

1.03 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: Include the following:
      1. Layout and attachment details.
      2. Locations and details of items which penetrate, are to be coordinated with, or supported by the ceilings.
      3. Ceiling perimeter detail.
   C. Samples: For each exposed product and for each color and finish specified.

1.04 INFORMATIONAL SUBMITTALS
   A. Product Certificates: Manufacturer's certifications that metal ceiling assembly complies with specified requirements.
   B. Product Test Reports: For metal ceiling assembly, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

1.05 QUALITY ASSURANCE
   A. Installer Qualifications: Minimum 5 years experience under current organizational structure.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver metal ceiling assembly components to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
   B. Handle metal ceiling assembly components carefully to avoid damage.

1.07 FIELD CONDITIONS
   A. Do not install metal ceiling assemblies until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide METALWORKS™ Blades - Classics by Armstrong Ceiling and Wall Solutions or comparable product by the following:
   1. USG® Ceilings Plus®.
   2. Substitutions will be considered.

2.02 PERFORMANCE CRITERIA

A. Surface-Burning Characteristics: ASTM E84; Class A. Identify products with appropriate markings of applicable testing agency.

B. Acoustical Performance Requirements: Provide metal ceiling assemblies identical to those tested by a qualified testing agency for the following acoustical properties per test methods indicated:
   1. Identify each carton of material with appropriate markings of applicable testing agency.
   2. Sound Absorption Average (SAA): Tested for SAA per ASTM C423 and rated for not less than 0.92 SAA.

1.08 METAL CEILING ASSEMBLY DESCRIPTION

A. Metal ceiling assemblies consist of a metal ceiling system comprised of formed aluminum perforated and insulated bars factory-finished and suspended from a direct-hung ceiling suspension system in a linear pattern.

B. Aluminum Bars/Baffles: Minimum 0.040 inch thick aluminum sheet perforated and formed into rectangular profiles of 1 inch wide by 6 inch high in various lengths with top return formed for clip attachment to suspension grid.
   1. End Caps: Metal matching bars; fabricated to fit and conceal exposed ends of bars.
   2. Aluminum Bar Finish: Factory applied in the following finish and color:
      b. CMA Paint Finish Color: Whitelume (WHA)

1.09 SUSPENSION SYSTEM

A. Ceiling Suspension-System: Manufacturer's standard direct-hung system complying with applicable requirements in ASTM C 635.
   2. Main and Cross Tees: Steel double-web construction with 15/16 inch type exposed flange.
   4. Color: As indicated or, if not indicated, as selected from manufacturer's full range.

B. Attachment Devices: Size for five times design load indicated in ASTM C635, Table 1, Direct Hung unless otherwise indicated.

C. Wire for Hangers, Braces, and Ties: Provide the following:

D. Edge Moldings: Manufacturer's standard moldings matching suspension-system tees, to conceal ends of tees.
1.10 MATERIALS

A. Aluminum Sheet: ASTM B209, stretcher leveled.

B. Steel Sheet: ASTM A1003, Commercial Grade, Electrogalvanized.

C. Acoustical Fill: Black fiberglass fleece acoustic infill bag.
   1. Surface-Burning Characteristics: ASTM E84; Class A.

1.11 FABRICATION

A. Cut metal ceiling assembly bars to size at perimeter edges and to accommodate penetrating fire suppression, mechanical, and electrical items.

PART 2 - EXECUTION

2.01 EXAMINATION

A. Verification of Conditions:
   1. Examine areas and conditions, including structural framing and substrates to which metal ceiling assemblies attach or abut, with installer present, for compliance with requirements for installation tolerances, clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
   2. Verify that layout of hangers will not interfere with other work.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

2.02 PREPARATION

A. Measure each ceiling area and establish layout of metal ceiling assemblies to balance border widths at opposite edges of each ceiling. Comply with reflected ceiling plans.

B. Coordinate metal ceiling assembly layout with fire suppression work, mechanical work, electrical fixtures, and other suspended or permanent construction that penetrates the ceiling.

2.03 SUSPENSION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions, approved submittals, ASTM C636, CISCA's "Ceiling Systems Handbook", and as specified herein.

B. Suspend ceiling hangers from building's structural members as follows:
   1. Attach hangers to structural members or to post-installed anchors or power-actuated fasteners that extend through permanent metal forms or floor deck into concrete.
      a. Do not support ceilings directly from permanent metal forms or floor deck.
      b. Do not attach hangers to steel deck tabs.
      c. Do not attach hangers to steel roof deck.
   2. Install carrying channels or other supplemental support, designed to support imposed loads, for attachment of hanger wires in the following locations:
      a. Where spacing of structural members does not permit installation of hanger wires at spacing required.
      b. Where ductwork, equipment, and other non-structural items within ceiling plenum interfere with hanger spacing.
   3. Suspend main tees from overhead construction or carrying channels with hanger wires spaced 48 inches on center along the length of the main runner. Install hanger wires plumb and straight.
4. Install cross tees at 48 inch spacing between main tees and level the suspension system.
5. Brace suspension assembly as required to prevent sway movement. Secure bracing wires to ceiling suspension members and to supports per specified standards. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

C. Install wall moldings at intersection of metal ceiling assemblies and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.

2.04 BAR INSTALLATION

A. Hang bars from suspension grid with attachment clips.
B. Neatly cut ends of bars as required at perimeter edges and penetrations. Ensure each bar is supported by not less than two tees.
C. For Wall-to-Wall Metal Ceiling Assemblies: Cut bars using provide template tools to leave minimum 3/4 inch clearance from walls.
   1. At walls parallel to length of bars, space bars to maintain equal gap from walls to first bar.
   2. At walls perpendicular to length of bars, cut bar ends square and install end caps.
D. Install diagonal bracing as required to prevent ceiling sway.

2.05 CLEANING

A. Clean exposed surfaces of metal ceiling assemblies, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage.
B. Replace damaged components.

END OF SECTION 09 54 23.13
SECTION 09 65 19 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes resilient floor coverings of the following types:
   1. Resilient Tile:
      a. Vinyl composition tile.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION" for preparation of substrates to receive resilient flooring.
   4. Div. 09 Section "RESILIENT BASE AND ACCESSORIES" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS” minimum one week prior to commencing work of this Section.

B. Coordination: Coordinate requirements of this Section with Div. 09 Section "COMMON WORK RESULTS FOR FLOORING PREPARATION" for preparation of substrates to receive resilient flooring.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,”

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Indicate the following for areas to receive resilient floor coverings:
   1. Type of substrate.
   2. Extent of resilient floor coverings with location of edge moldings. Show cutouts.
   3. Floor covering type, color, and run number including locations where run number changes occur. Use same designations indicated on Drawings.
   4. Tile joint layout.
   5. Pattern, location, and direction.

C. Samples: For each type and color of resilient flooring for verification. Label each Sample with manufacturer's name, material description, color, pattern, and designation as indicated on Drawings and in schedules.
   1. Sample Size:
      a. For Tile: Full size.
1.05 INFORMATION SUBMITTALS
A. Manufacturers’ instructions. Indicate special procedures and conditions requiring special attention.

1.06 CLOSEOUT SUBMITTALS
A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

1.07 DELIVERY, STORAGE, AND HANDLING
A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
5. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.
6. Store floor tiles on flat surfaces.

1.02 FIELD CONDITIONS
A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Minimum Conditions: Do not install resilient flooring until after other finishing operations, including painting, have been completed.
2. Close spaces to traffic during installation and for 48 hours after completion of installation.
3. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
4. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient flooring during the following time periods:
   a. 48 hours before installation.
   b. During installation.
   c. 48 hours after installation.
5. Do not install resilient flooring until flooring products are same temperature as space where they are to be installed.
6. Maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F for duration of Project.

1.03 WARRANTY
A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 5 year warranty providing coverage against failures in materials or workmanship.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 DESCRIPTION

A. Product Options: Information on Drawings and in Specifications establishes requirements for flooring aesthetic effects and performance characteristics. Aesthetic effects are indicated by basis of design product colors as they relate to one another and to other construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

2.03 RESILIENT TILE FLOORING

A. Vinyl Composition Floor Tile (VCT):

1. Products: As indicated by manufacturer's designations in the Finish Material Schedule.
2. Manufacturers:
   a. Armstrong World Industries, Inc.
   b. Congoleum Corporation.
   c. Mannington Mills, Inc.
   d. Tarkett, Inc.
   e. Comparable products by other manufacturers will be considered.
5. Size: 12 by 12 inches.
6. Thickness: 0.125 inch.
7. Colors and Patterns: As indicated by manufacturer's designations in the Finish Material Schedule.

2.04 ACCESSORIES

A. Provide installation accessories provided or approved by floor covering manufacturer to suit products and substrate conditions indicated.
B. Adhesives: Water-resistant type.
C. Resilient Base and Edge Strips: Per Section "RESILIENT BASE AND ACCESSORIES."
D. Floor Polish: Protective liquid floor polish products as recommended by floor covering manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and per Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

3.02 RESILIENT FLOORING INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions and recommendations.
B. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, door frames, edgings, thresholds, and nosings.
C. Extend floor coverings into toe spaces, door reveals, closets, and similar openings. Extend floor coverings to center of door openings.

D. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.

E. Install floor coverings on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining flooring. Tightly adhere floor coverings edges to substrates that abut covers and to cover perimeters.

F. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.03 FLOOR TILE INSTALLATION

A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width, unless otherwise indicated. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   1. Lay floor tiles square with room axis.
   2. Locate change of color or pattern between rooms under door centerline.

B. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
   1. Lay tiles with grain running as directed.

C. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering surfaces before applying liquid floor polish.
   1. Apply polish in three coats.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   1. Comply with flooring manufacturer's written instructions for cleaning and protection of floor coverings.
   2. Perform the following operations immediately after completing flooring installation:
      a. Remove adhesive and other blemishes from exposed surfaces.
      b. Sweep and vacuum surfaces thoroughly.
      c. Damp-mop floor coverings to remove marks and soil.

3.05 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:
   1. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
   2. Cover resilient flooring until Substantial Completion.

END OF SECTION 09 65 19
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes resilient base and molding accessories.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 09 Sections for floor coverings referencing this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate Work of this Section with floor covering Sections to ensure proper type and sizing of edge molding accessories.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section “SUBMITTAL PROCEDURES,”

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Coordinate with floor covering shop drawings to indicate the following:
   1. Extent of resilient base and accessories showing locations, types, colors, sizes, and end joint locations.

C. Samples: For each type, color, and texture specified for initial selection and verification. Label each Sample with manufacturer's name, material description, color, texture, and designation as indicated on Drawings and in schedules.
   1. Sample Size: Not less than 12 inches.

1.05 INFORMATION SUBMITTALS

A. Manufacturers’ instructions. Indicate special procedures and conditions requiring special attention.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section “OPERATION AND MAINTENANCE DATA.”

1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.
1.08 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Minimum Conditions: Do not install resilient products until after other finishing operations, including painting and floor coverings, have been completed.
   2. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
      a. 48 hours before installation.
      a. During installation.
      b. 48 hours after installation.
   2. Do not install resilient products until products are same temperature as space where they are to be installed.
   3. Maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F for duration of Project.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS

A. Basis Of Design Product: Where a basis of design product is scheduled, provide the named product or a comparable product by one of the following:
   1. Armstrong World Industries, Inc.
   2. Burke Mercer Flooring Products, Division of Burke Industries Inc.
   3. Flexco.
   4. Johnsonite; A Tarkett Company.
   5. Roppe Corporation, USA.
   6. Comparable products by other manufacturers will be considered.

2.03 RESILIENT WALL BASE

A. Resilient Base: ASTM F1861; Type TS rubber, vulcanized thermoset; Group 1-solid (homogeneous).
   1. Style and Location:
      a. Style B, Cove: Provide in areas with resilient flooring and carpet.
   2. Thickness: 0.125 inch.
   3. Height: 4 inches.
   4. Lengths: Coils in manufacturer’s standard length.
   5. Outside Corners: Preformed.
   6. Inside Corners: Job formed or preformed.
   7. Colors and Patterns: As indicated or, if not indicated, as selected by Architect from full range of industry colors.

2.04 RESILIENT MOLDING ACCESSORIES

A. Resilient Molding Accessories: Rubber, vulcanized thermoset.
B. Provide edge moldings of the following types in locations indicated:
   1. Adapters: Provide where carpet and resilient floor covering materials meet.
      a. Receiver Tracks: Manufacturer's standard product to receive adapter.
   2. Transition Strips: Provide where resilient floor covering materials of differing thicknesses abut.
   3. Reducers: Provide where carpet and resilient floor covering materials terminate at exposed concrete floors.

C. Profiles and Dimensions: As indicated or, if not indicated, as selected by Architect from full range.

D. Colors and Patterns: As indicated or, if not indicated, as selected by Architect from full range of industry colors.
   1. Finish: Satin.

### 2.05 INSTALLATION ACCESSORIES

A. Provide installation accessories provided or approved by floor covering manufacturer to suit products and substrate conditions indicated

B. Adhesives: Water-resistant type.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

#### 3.02 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable with vertical joints and without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
   1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
      a. Miter or cope corners to minimize open joints.
3.03 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.04 CLEANING

A. Per Div. 01 Sections "PROGRESS CLEANING" and "FINAL CLEANING" and as follows:
   1. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
   2. Perform the following operations immediately after completing resilient product installation:
      a. Remove adhesive and other blemishes from exposed surfaces.
      b. Sweep and vacuum surfaces thoroughly.
      c. Damp-mop surfaces to remove marks and soil.

END OF SECTION 09 65 13
SECTION 09 67 23 - RESINOUS FLOORING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes fluid-applied resinous floor finish for decorative and protective uses.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 09 Section "RESINOUS MATRIX TERRAZZO FLOORING" for thinset, epoxy-matrix terrazzo.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include physical and performance characteristics. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples: For each type and color of exposed products for verification.
   1. Sample Size:
      a. 6 x 6 square for flooring samples.

1.05 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Manufacturer's certificate of installer approval.
   2. Installer's certificate of compliance.
   3. Material certificates.

B. Test and Evaluation Reports:
   1. Material test reports for each type of flooring.

1.06 CLOSEOUT SUBMITTALS:

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

1.07 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
1. Manufacturer Qualifications: Minimum 5 years experience under current organizational structure.
2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
   a. Company: A firm or individual certified, licensed, or otherwise qualified by manufacturer for installation of Products specified in this Section.
      1) A manufacturer's willingness to sell its materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
   b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.
   c. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress.

1.08 DELIVERY, STORAGE AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   1. Maintain minimum temperature of 55 degrees F in storage area unless otherwise instructed by manufacturer.
   2. Store materials in installation area for 3 days prior to installation to achieve temperature stability.

1.09 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application for not less than 3 days prior to, during, and for 48 hours after installation of materials.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

1.10 WARRANTIES

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard 5 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Failures include, but are not limited to, the following:
      a. Delamination from substrate.
      b. Failure of system to meet performance requirements.
      c. Deterioration of finish beyond normal use or weathering.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.
2.02 MANUFACTURERS

A. Basis of Design Product: Softop Topfloor BC by Sherwin Williams or comparable product by one of the following:
   3. NEOGARD; Division of JONES-BLAIR.
   4. Stonhard, Inc.
   5. Tennant Co.
   6. Tnemec Company, Inc.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.03 SYSTEM DESCRIPTION

A. Resinous Flooring: Provide a seamless, monolithic, decorative and protective, resin-based broadcast-type floor-surfacing system which is flexible and abrasion-resistant with integral cove base.
   2. Overall System Thickness: Minimum thickness of 1/8 inch.
   3. Wearing Surface: Manufacturer’s standard texture.
   5. Finish Color: As indicated.

2.04 PERFORMANCE CRITERIA

A. Comply with applicable provisions of referenced standards:

B. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D412</td>
<td>1500 psi minimum at 7 days</td>
</tr>
<tr>
<td>Bond Strength (Adhesion)</td>
<td>ACI 503R</td>
<td>350 psi minimum with 100 percent concrete failure</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D412</td>
<td>80 percent</td>
</tr>
<tr>
<td>Indentation</td>
<td>ASTM F1914</td>
<td>1 percent maximum (140 lb load)</td>
</tr>
<tr>
<td>Impact Resistance</td>
<td>ASTM D4226</td>
<td>&gt;160 in/lb (160 lb load)</td>
</tr>
</tbody>
</table>

C. Surface-Burning Characteristics: ASTM E 84; Class A.

D. Dynamic Coefficient of Friction (DCOF): For flooring installed on level, interior walkway surfaces expected to be walked upon when wet, provide products with DCOF of not less than 0.42 as determined by testing identical products per method specified in paragraph 9.6 of ANSI A137.1.

2.05 MATERIALS
A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.

B. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.

C. Bonding Coat:
   1. Resin: Epoxy.
   2. Formulation Description: High solids.
   3. Type: Pigmented.
   5. Number of Coats: One at manufacturer's recommended rate.
   6. Aggregates: Manufacturer's standard rubber.

D. Grout Coat:
   1. Resin: Epoxy.
   2. Formulation Description: High solids.
   3. Type: Pigmented.
   4. Thickness: 16-20 mils WFT.

E. Seal Coat:
   1. Resin: Urethane.
   2. Formulation Description: High solids.
   3. Type: Pigmented.
   4. Number of Coats: One at manufacturer's recommended rate.

2.06 ACCESSORIES

A. Adhesives, and Sealers: As recommended by resinous flooring manufacturer.

B. Precast, Integral Cove Base: Impact-resistant, polymer-resin, cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.
   1. Radius Cove Base: 4-inch high base molding forming approximately one inch radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.
      a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and 3/4- to 1-inch bullnose outside corners.
   2. Cove Installation Adhesive: As recommended in writing by accessory manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and per Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."
   1. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   2. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Protect surrounding areas and surfaces from damage or disfiguration.
C. 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. Roughen concrete substrates as follows:
      a. 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.
      b. Comply with NACE No. 6/SSPC-SP13, with a Concrete Surface Profile (CSP) of 3 or greater per the International Concrete Repair Institute (ICRI) Technical Guideline No. 03732.
   2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

D. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
   1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.02 APPLICATION

A. Mix and apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Apply component coats in number indicated and at spreading rates recommended in writing by manufacturer.
   2. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   3. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   4. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Precast Integral Cove Base: Adhesively install precast cove base before applying flooring coats and in accordance with manufacturer's written instructions.

D. Bonding Coat: Apply self-leveling slurry body coats in thickness indicated for flooring system.
   1. Aggregates: Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

E. Grout Coat: Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.

F. Seal Coat: Apply seal coat at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.03 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove protective measures and clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.
3.04 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Barricade area to protect flooring until cured.

C. Prohibit traffic on floor finish for 48 hours after final cure is complete unless manufacturer recommends a longer period.

D. Protect finished floor by covering with 30 pound building paper or equivalent means recommended in writing by resinous flooring manufacturer until just prior to Substantial Completion.

END OF SECTION 09 67 23
SECTION 09 68 00 - CARPETING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes carpeting of the following types.
   1. Tufted broadloom carpet.
   2. Modular carpet tile.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 09 Section "COMMON WORK RESULTS FOR FLOORING PREPARATION" for preparation of substrates to receive carpeting.
   4. Div. 09 Section "RESILIENT BASE AND ACCESSORIES" for resilient wall base and accessories installed with carpet.

1.02 REFERENCES

A. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. Carpet and Rug Institute (CRI):
      a. CRI 104 - Standard for Installation of Commercial Carpet.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.
   1. Review methods and procedures related to carpet installation including, but not limited to, the following:
      a. Review delivery, storage, and handling procedures.
      b. Review ambient conditions and ventilation procedures.
      c. Review subfloor preparation procedures.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include data on physical and performance characteristics including durability and fade resistance, sizes.
   2. Include installation recommendations for each type of substrate.

B. Shop Drawings: Indicate the following for areas to receive carpeting:
   1. Method of installation and type of substrate (e.g. "direct glue on concrete").
   2. Extent of carpeting with location of edge moldings. Show cutouts.

09 68 00 - 1
CARPETING
3. Carpet type, color, and dye lot including locations where dye lot changes occur. Use same designations indicated on Drawings.
5. Tile joint layout.
6. Pattern, starting point, repeat size, location, and direction.
7. Pile direction.

C. Samples: For each type and color of carpeting for verification. Label each Sample with manufacturer's name, material description, color, pattern, and designation as indicated on Drawings and in schedules.
8. Broadloom Carpet: 12 inch square with seam in center.

1.06 INFORMATIONAL SUBMITTALS
A. Test Reports:
   1. Product test reports for carpet.

B. Manufacturers’ instructions. Indicate special procedures and conditions requiring special attention.

C. Sample warranties.

1.07 CLOSEOUT SUBMITTALS
A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA." Include the following:
   1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet.

B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES".

1.08 DELIVERY, STORAGE, AND HANDLING
A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
   2. Deliver carpet in original mill protective covering with mill register numbers and tags attached.

1.09 FIELD CONDITIONS
A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Minimum Conditions: Do not deliver or install carpet until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
   2. Comply with CRI Carpet Installation Standard for temperature, humidity, and ventilation limitations.
   3. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
1.10 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES".

B. Standard Warranty: Furnish manufacturer's standard warranty providing coverage against failure in materials or workmanship as follows:
   1. Carpet failures include, but are not limited to, the following:
      a. More than 10 percent loss of face fiber for broadloom carpet.
      b. Edge raveling for broadloom carpet.
      c. More than 10 percent edge raveling for carpet tile.
      d. Dimensional stability for carpet tile.
      e. Snags.
      f. Runs.
      g. Loss of tuft bind strength.
      h. Excess static discharge.
      i. Delamination.
      j. Carpet Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 TUFTED BROADLOOM CARPET

A. Products: As indicated by manufacturer's designations in the Finish Material Schedule.

2.03 CARPET TILE

A. Products: As indicated by manufacturer's designations in the Finish Material Schedule.

B. Size: As indicated on Drawings.

2.04 APPLIED CARPET TREATMENTS

A. Soil-Resistance Treatment: Manufacturer's standard material.

B. Antimicrobial Treatment: Manufacturer's standard material.

2.05 ACCESSORIES

A. Provide installation accessories provided or approved by carpet manufacturer to suit products and substrate conditions indicated

B. Carpet Adhesive: Water-resistant, mildew-resistant, nonstaining formulation. Provide releasable type for carpet tile.

C. Seam Adhesive: Hot-melt adhesive tape or similar product.
PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and per Div. 09 Section "COMMON WORK RESULTS FOR FLOOR SUBSTRATE PREPARATION."

3.02 INSTALLATION, GENERAL

A. Comply with CRI Carpet Installation Standard and carpet manufacturers' written installation instructions.

B. Verify carpet match before cutting to ensure minimal variation between dye lots.

C. Lay out carpet and locate seams in accordance with shop drawings.
   1. Locate seams in area of least traffic, out of areas of pivoting traffic, and parallel to main traffic.
   2. Do not locate seams perpendicular through door openings.
   3. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.
   4. Locate change of color or pattern between rooms under door centerline.
   5. Provide monolithic color, pattern, and texture match within any one area, unless otherwise indicated.

D. Install carpet tight and flat on substrate, well fastened at edges, with a uniform appearance.

E. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

F. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.03 BROADLOOM CARPET INSTALLATION

A. Comply with CRI Carpet Installation Standard and carpet manufacturers' written installation instructions for the following:
   1. Direct-glue-down installation.

B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Do not bridge building expansion joints with carpet.
3.04 CARPET TILE INSTALLATION

A. Comply with CRI Carpet Installation Standard, Section 10, "Carpet Tile Installation," and with carpet tile manufacturer's written installation instructions.

B. Blend carpet from different cartons to ensure minimal variation in color match. Maintain dye lot integrity. Do not mix dye lots in same area.

C. Installation Method: As recommended in writing by carpet tile manufacturer.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Immediately after installing carpet:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
   2. Remove yarns that protrude from carpet surface.

3.06 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:
   2. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet and adhesive manufacturers.

END OF SECTION 09 68 00
SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Vinyl wall covering.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 09 Section "PAINTING" for priming wall surfaces.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.

B. Samples: For each type and color of exposed products for verification.
   1. Sample Size: Full width by 36 inch long.
   2. Sample from same print run or dye lot to be used for the Work, with specified treatments applied. Mark top and face of fabric.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

1.06 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Installer Qualifications: Minimum 5 years experience under current organizational structure.
      a. Company: An employer of workers trained for installation of Products specified in this Section.
      b. Project Experience: Minimum 5 years experience on at least 5 projects of similar nature in past 5 years.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
1.08 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:

B. Do not deliver or install wall coverings until spaces are enclosed and weather tight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

C. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor’s options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE CRITERIA

A. Surface-Burning Characteristics: ASTM E 84; Class A.

2.03 WALL COVERINGS, GENERAL

A. General: Provide rolls of each type of wall covering from same print run or dye lot.

2.04 VINYL WALL COVERING

A. Vinyl Wall-Covering Standards: Provide mildew-resistant products complying with the following:
   1. FS CCC-W-408D and CFFA-W-101-D for Type III, Heavy-Duty products.
   2. ASTM F 793 for peelable wall coverings that qualify as Category IV-VI, Type I, Type II, or Type III, Commercial Serviceability products.
   3. Products: As indicated by manufacturer’s designations in the Finish Material Schedule.

2.05 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer.

B. Primer/Sealer: Mildew resistant, complying with requirements in Div. 09 Section "PAINTING" and recommended in writing by wall-covering manufacturer for intended substrate.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
B. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

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

D. Comply with manufacturer's written instructions for surface preparation.

E. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

F. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
   2. Painted Surfaces: Treat areas susceptible to pigment bleeding.

G. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

H. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

I. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

J. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations.

B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install reversing every other strip.

E. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.

F. Match pattern 72 inches above the finish floor.

G. Install seams vertical and plumb at least 6 inches from outside corners and 3 inches from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

I. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.
3.03 CLEANING

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00
SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes painting and decorating new and existing exterior and interior surfaces.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 REFERENCES

A. Definitions:
   1. Definitions in MPI and PDCA Standards apply to work of this Section.
   2. Paint Gloss: The sheen rating of applied paint, in accordance with MPI Gloss Levels G1 through G7 measured per ASTM D523.
   3. System DFT: Dry film thickness of entire coating system unless otherwise noted.

B. Reference Standards: Perform Work according to standards specified and as follows unless modified by requirements in the Contract Documents.
   1. Make available via internet access or maintain on site a copy of each standard affecting the Work of this Section.
   2. Master Painter's Institute (MPI):
   3. Painting and Decorating Contractors of America (PDCA):

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Scheduling: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
   1. Schedule painting operations to prevent disruption of and by other trades.
   2. Schedule painting operations in occupied facilities to prevent disruption of occupants in and near the building. Conduct painting operations during times as directed based on Owner’s operating requirements. Schedule work such that painted surfaces will have time to dry before occupants are affected. Obtain written authorization from Owner for changes in work schedule.

1.04 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section “SUBMITTAL PROCEDURES.”
1.05 ACTION SUBMITTALS

C. Product Data: For each type of product.
   
D. Samples for Verification: For each type of finish system and in each color and gloss required.
   1. Opaque Color and Gloss Samples:
      a. Quantity: Two samples of each opaque topcoat finish in each color and gloss level scheduled.
      b. Prepare on draw-down cards comparable to BYK-Gardner 2826 byko-chart plain white. Apply sufficient coating thickness to provide proper hiding and appearance.
      c. Label each sample to indicate material, color, and gloss level.
   
E. Product Schedule: For each MPI System proposed for use, include the following:
   1. Printout from MPI Architectural Painting Specification Manualor MPI Maintenance Repainting Manual of current "MPI System" for each new system scheduled, showing MPI Code number, Finishing System, Coats, Grades, and MPI Product numbers with the proposed system, gloss, and products highlighted.
   2. Printout of current "MPI Approved Products List" for each MPI Product category scheduled, with proposed products highlighted.

1.02 INFORMATIONAL SUBMITTALS

A. Manufacturers’ instructions.

1.03 CLOSEOUT SUBMITTALS

A. Provide an itemized list, complete with manufacturer, paint type and color coding for products incorporated in the Work for Owner’s later use in maintenance.

B. Provide to Owner Material Safety Data Sheets (MSDS) for extra stock materials.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Process and transmit in accordance with Div. 01 Section "CLOSEOUT PROCEDURES"

B. Extra Stock Materials: Furnish from same batch or product run prior to Substantial Completion.
   1. Finish Coat Paints: 5 percent, but not less than 1 unopened gallon in each opaque color and gloss level applied.

1.05 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
   1. Applicator Qualifications: Minimum five years experience under current organizational structure.
      a. Staff: Employ a competent foreman to supervise Work of this Section. Foreman shall be present whenever Work is in progress. Only qualified journeypersons, as defined by local jurisdiction shall be engaged in painting and decorating work. Apprentices may be employed provided they work under direct supervision of a qualified journeyperson in accordance with trade regulations.
   
B. Field Samples: Per Div. 01 Section "FIELD SAMPLES" and as follows:
   1. Apply samples for each type, color, and gloss level of paint and coating product specified.
   2. Size:
      a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
b. Small Areas and Items: Architect will designate items or areas required.
3. Apply samples on each substrate required.
5. Final approval of color selections will be based on samples.
   a. If preliminary color selections are not approved, apply additional samples at no
      added cost to Owner.
6. Approved samples may become part of the completed Work if undisturbed at time of
   Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:

A. Deliver painting materials in sealed, original labeled containers bearing manufacturer’s name,
   brand name, type of paint or coating and color designation, standard compliance, materials con-
   tent as well as mixing and/or reducing and application requirements.

B. Where toxic and/or volatile / explosive / flammable materials are being used, provide adequate
   fireproof storage lockers and take all necessary precautions and post adequate warnings (e.g.
   no smoking) as required.

C. 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.

1.07 FIELD CONDITIONS

A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
   1. Apply paints only when the following conditions exist unless specifically pre-approved in
      writing by Architect and applied product manufacturer:
      a. Temperature of surfaces to be painted and ambient air temperatures are between
         50 and 95 deg F.
      b. Relative humidity is less than 85 percent.
      c. Dew point is greater than 5 degrees F variance between the air / surface tempera-
         ture.
      d. Surfaces are not damp, frozen, or wet.
      e. Maximum moisture content of substrates is within limits established by MPI.
      f. Light level is greater than 30 foot candles on surfaces to be painted.
   2. Do not apply exterior coatings in snow, rain, fog, or mist.
   3. Provide continuous ventilation and heating facilities if required to maintain ambient air
      and substrate temperatures above minimum requirements for 24 hours before, during
      and after paint application. Provide adequate lighting.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to prod-
   ucts.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting
   Products and procedures for offering comparable products.
2.02 MANUFACTURERS

A. Manufacturers:
   1. Benjamin Moore & Co.
   2. PPG Architectural Finishes, Inc.
   4. Comparable products by other manufacturers will be considered.

B. Manufacturer Source Limitations:
   1. Obtain primary paint products through one source from a single manufacturer for entire Project, unless otherwise acceptable to Architect.
   2. Furnish secondary products and accessory materials only of type and from source recommended by manufacturer of primary paint products.

2.03 DESCRIPTION

A. Apply paint to indicated surfaces.

B. Do not paint the following, unless otherwise indicated:
   1. Surfaces concealed or inaccessible in finished construction.
   2. Surfaces specifically scheduled or indicated to remain unfinished or unpainted.
   3. Items with integral finish or factory-applied final finish.
   5. Decorative concrete unit masonry.
   7. Aluminum and aluminum based alloys, copper and copper based alloys, lead and lead based alloys, nickel and nickel based alloys, stainless steel, plated architectural metals, and "weathering" metals.
   8. Areaway grating.
   10. Decorative plastic laminates.
   11. Synthetic countertops.
   12. Elastomeric membranes, flashings, and roofing materials.
   13. Sealants and calking, other than painter's caulk (paintable acrylic/latex type).
   15. Rubber, vinyl, plastic, and other resilient seals and bumpers.
   16. Moving parts of operating equipment such as valve and damper operators, linkages, sensing devices, motor and fan shafts.
   17. Labels of independent testing agencies, code-required labels, name plates, identification or performance rating labels, or nomenclature plates.

2.04 PAINT MATERIALS, GENERAL

A. Products: Per the Paint Systems and Paint Products Schedules and listed in the latest edition of the MPI "Approved Product List." Products shall be from a single manufacturer for each system used.
   1. If selected manufacture does not produce an MPI evaluated product listed in the Paint Products Schedule, submit manufacturer's recommended comparable product for approval.
   2. Provide lead and mercury free materials.

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.

2.05 SECONDARY PRODUCTS AND ACCESSORY MATERIALS

A. Muriatic Acid, Mildewcide, TSP (Tri-Sodium Phosphate), Acidic-Detergent, Zinc Sulfate, Sodium Metasilicate, and Solvents: Commercially available, non-damaging to surface being cleaned; acceptable to paint manufacturer.

B. Spackling Compound, Putty, Plastic Wood Filler, Liquid De-Glosser, Latex Patching Plaster, Latex Base Filler, Linseed Oil, Shellac, Thinners, Solvents, and Other Materials Not Specified But Required To Achieve Finishes Specified: Pure, of highest commercial quality, compatible with coatings and acceptable to coating manufacturer.

C. Painter's Caulk: Paintable acrylic/latex sealant per Div. 07 Section "JOINT SEALANTS."

2.06 EQUIPMENT

A. Painting and Decorating Equipment: Meeting best trade standards for type of product and application.

B. Spray Painting Equipment: Of ample capacity, suited to type and consistency of paint or coating being applied and kept clean and in good working order at all times.

2.07 MIXING

A. Unless otherwise specified herein or pre-approved, use ready-mixed, pre-tinted colors matching approved samples. Site tinting will not be permitted.

1. Tint each undercoat a progressively lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

B. Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

C. Thoroughly mix and stir coatings before use to ensure homogeneous dispersion of ingredients. Prior to application, box (blend) multiple containers of same material and color by pouring from one container to another several times to ensure uniform consistency, color, and smoothness.

D. Mix only in clean mixing pails of material recommended by manufacturer to avoid contamination.

E. Remove film which may form on surface of material in containers and strain material before using. Stir frequently during use to maintain pigments in suspension. Do not stir film into material.

F. Apply coatings of consistency recommended by manufacturer. Thin only within recommended limits using thinner approved by coating manufacturer.

1. Where thinner is used, do not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.
2. If required, thin paint for spraying according in accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer.

2.08 FINISHES AND COLORS
A. Colors: As indicated or, if not indicated, as selected from manufacturer's full range.

2.09 SOURCE QUALITY CONTROL
A. See Div. 01 Section "QUALITY REQUIREMENTS" for requirements for services of independent testing laboratories and agencies to perform specified testing and inspecting.

B. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   2. Testing agency will perform tests for compliance with product requirements.

C. Non-Conforming Work:
   1. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION
A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:
B. Verification of Conditions: Per PDCA 4 and MPI Standards, examine substrates and conditions with paint applicator present. Prepare written report, endorsed by applicator, listing conditions or surfaces that will adversely affect work of this Section.
   1. The painter shall not be responsible for the condition of substrates or for correcting defects and deficiencies in substrates which may adversely affect the painting work except for minimal work normally performed by the painting trade as defined under MPI preparation requirements and as indicated herein. It shall always, however, be the responsibility of the painter to ensure surfaces are properly prepared before paint is applied.
   2. Require installers of previous work to repair substrate defects and sand ready for painting, particularly defects that are apparent only after application of the first coat of paint.
   3. Start of finish painting of defective surfaces indicates acceptance of substrate and costs of making good defects shall be borne by the painter including repainting of entire defective surface. Touch up painting will not meet this requirement.
C. Review other Sections specifying prime coats and factory finishes to ensure compatibility of paint coating system for the various substrates.
   1. Review Product Data and surface preparation procedures transmitted from shop painting applicators.
   2. Test compatibility of existing coatings, including shop applied primers and previously applied coatings, by applying specified special coating to small, inconspicuous area.
3. If specified coating lifts or blisters existing coating, apply barrier or tie coat as recom-
mended by coating manufacturer.
4. If no compatible barrier or tie coat exists, remove existing coating completely and apply
coating system as specified for new work.

D. Protect adjacent surfaces and areas, including rating and instruction labels on doors, frames,
equipment, piping, etc., from painting operations and damage using drop cloths, shields, mask-
ing, templates, or other suitable protective means. Repair damage caused by failure to provide
such protection.

E. Remove and securely store items already in place that are removable and are not to be painted
from wall and ceiling surfaces, doors and frames, prior to painting. If removal is impractical or
impossible because of size or weight of item, provide surface-applied protection or masking be-
fore surface preparation and painting.
1. Use workers skilled in the trades involved to remove and reinstall items.
2. Remove hardware, surface fittings, fastenings, covers, electrical plates, toilet and bath
accessories, light fixture trim, and similar items.
3. Prior to finishing mechanical and electrical items, remove louvers, grilles, covers, and ac-
cess panels and finish separately.
4. Carefully clean and replace items upon completion of painting work in each area. Do not
use solvent or reactive cleaning agents on items that will mar or remove finishes (e.g.
lacquer finishes).
5. Remove doors before painting to paint bottom and top edges and then re-hang.
6. Remove surface-applied protection as soon as practical after painting.

3.02 EXISTING SURFACES TO BE REPAINTED

A. Condition of Existing Surfaces:
1. Prior to commencement of repainting work, thorou-
ghly examine and test, as required,
surfaces scheduled to be repainted and report in writing to the Architect and Owner con-
ditions and surfaces that may adversely affect work of this Section.
2. Assess the degree of surface deterioration (DSD) using the assessment criteria indicated
below and in the MPI Maintenance Repainting Manual. In general the MPI DSD ratings
and descriptions are as follows:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSD-0</td>
<td>Sound Surface (may include visual (aesthetic) defects that do not affect film’s protective properties).</td>
</tr>
<tr>
<td>DSD-1</td>
<td>Slightly Deteriorated Surface (may show fading; gloss reduction, slight surface contamination, minor pin holes scratches, etc.) / Minor cosmetic defects (runs, sags, etc.).</td>
</tr>
<tr>
<td>DSD-2</td>
<td>Moderately Deteriorated Surface (small areas of peeling, flaking, slight cracking, staining, etc.).</td>
</tr>
<tr>
<td>DSD-3</td>
<td>Severely Deteriorated Surface (heavy peeling, flaking, cracking, checking, scratches, scuffs, abrasion, small holes and gouges).</td>
</tr>
<tr>
<td>DSD-4</td>
<td>Substrate Damage (repair or replacement of surface required by others).</td>
</tr>
</tbody>
</table>

3. If structural or DSD-4 substrate defects are discovered prior to or after surface prepara-
tion notify Architect and await decision on level of repair required before proceeding.
4. Do not commence repainting until all such DSD-4 adverse conditions and defects have
been corrected and surfaces and conditions are acceptable.

B. Use finish coat of respective new surface paint system for minor repair of existing finishes. Use
system primer where existing finishes are damaged down to bare surface.
3.03 SURFACE PREPARATION

A. Comply with coating manufacturer's written instructions, requirements in "MPI Architectural Painting Specification Manual," "MPI Maintenance Repainting Manual," and requirements specified herein as applicable to substrates for products and paint systems indicated.

B. Preparation of Existing Exterior Surfaces:
   1. Where required, pressure wash exterior surfaces prior to repainting per MPI standards for type of surfaces and recommended pressures to ensure complete removal of loose paint, stains, dirt, and other foreign matter.
   2. Use qualified tradesman experienced in pressure water cleaning.
   3. Water hose cleaning will not be considered satisfactory, unless specifically specified.
   4. Allow sufficient drying time and test all surfaces using an electronic moisture meter before commencing work.

C. Sand, clean, dry, etch, neutralize and test surfaces under adequate illumination, ventilation and temperature requirements.

D. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

E. Preparing Non-Galvanized Iron and Steel Items for Field Priming: Clean surfaces to be primed. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   2. Interior steel members located in corrosive environments, high moisture environments, and equipment rooms: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   3. Where steel is to receive inorganic, zinc-rich, primer, prepare surfaces per SSPC-SP 10, "Near White Blast." Coordinate the required blast profile with the approved paint submittal prior to beginning surface preparation.
   4. Where steel is concealed in finished construction with no further finish or coatings, prepare surfaces per SSPC-SP 3, "Power Tool Cleaning."

   1. Newly Galvanized Surfaces: Perform Steps 1 (surface smoothing), 3 (rinse and dry), and 4 (surface profiling) below.
   2. Partially Weathered Surfaces: Perform Steps 1 (surface smoothing), 2 (cleaning), 3 (rinse and dry), and 4 (surface profiling) below.
   3. Fully Weathered Surfaces: Perform Steps 2 (cleaning), 3 (rinse and dry), and 4 (surface profiling) below.
   4. If unable to determine condition, assume the surface is partially weathered, and treat as Partially Weathered.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and touch up exposed areas with the same primer as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
   1. Verify shop primers have not exceeded manufacturer's exposure time prior to topcoating. If exceeded, follow prime coat manufacturer's recommendations for rework required prior to topcoating.
   2. If prime coat removal is required, remove existing shop primer completely by method as follows and apply coating system as specified for new work.
      b. Interior Locations: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
H. Apply painter's caulk to joints between painted door, window, and other frames and adjacent painted wall substrates.

3.04 APPLICATION

A. Unless otherwise specified herein, perform painting work per MPI Painting Manual Premium Grade finish requirements.
   1. Apply paints and coatings according to manufacturer's written instructions.
   2. Apply paints and coatings within an appropriate time frame after cleaning when environmental conditions encourage flash-rusting, rusting, contamination or the manufacturer's paint specifications require earlier applications.
   3. Coat all surfaces specified, scheduled, illustrated, and otherwise exposed unless specifically noted otherwise.
   4. Use applicators and techniques suited for paint and substrate indicated.
   5. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture (e.g. markerboards, tack boards, acoustic panels, etc.)
   6. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   7. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Block Filler: Apply in manner and with equipment recommended by coating manufacturer to the following Levels of Fill per PDCA P12:
   1. Level 1 - Economy Fill: Apply in interior non-public areas and stairways.
   2. Level 2 - Standard Fill: Apply in interior finished public areas, unless otherwise indicated.
   3. Level 3 - Premium Fill: Apply in exterior areas and interior kitchens, toilets, showers, baths, and laboratories.

C. Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
   1. Unless otherwise directed, apply a minimum of four coats of paint where deep or bright colors are used to achieve satisfactory results.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Produce sharp lines and color breaks.
   1. Number of coats specified are minimum number acceptable.
   2. Apply coating systems to total dry film thickness scheduled. Apply material at not less than manufacturer's recommended spreading rate. Do not exceed maximum single coat thickness recommended by coating manufacturer. Do not double-back with spray equipment building up film thickness of two coats in one pass.
   3. Allow previously applied coat to dry before next coat is applied.
   4. Sand and dust lightly between coats to provide an anchor for next coat and to remove defects visible from a distance up to 39 inches.
   5. Ensure that edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent of flat surfaces.
   6. Finish edges of coatings adjoining other materials or colors sharp and clean, without overlapping.

E. Finish Matching:
   1. Finish closets, niches, alcoves, and similar spaces the same as adjoining rooms, unless otherwise indicated.
2. Finish tops, bottoms, and edges of doors the same as door faces. When faces are different colors, finish edges of doors to match space from which they are visible when door is in partly open position.

3. Finish other surfaces not specifically scheduled to match color of adjoining surfaces.

3.05 FIELD QUALITY CONTROL / STANDARD OF ACCEPTANCE

A. Field Tests: Perform the following tests:
   1. Periodically test film thickness of each coat with wet film gage to ensure coatings are being applied to proper thickness.

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. 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.

C. Inspections: Architect will perform the following inspections:
   1. Inspect surfaces, preparation and paint applications.
   2. Request review of each applied coat by Architect before application of successive coats. Only reviewed coats will be considered in determining number of coats applied.
   3. Painted exterior and interior surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent to the inspector:
      a. Brush marks, roller marks, streaks, laps, runs, sags, drips, heavy stippling, hiding or shadowing by inefficient application methods, skipped or missed areas, and foreign materials in paint coatings.
      b. Evidence of poor coverage at fastener heads (bolts, rivets, screws, etc.), plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
      c. Damage due to touching before paint is sufficiently dry or any other contributory cause.
      d. Damage due to application on moist surfaces or caused by inadequate protection from the weather.
      e. Damage and/or contamination of paint due to blown contaminants (dust, spray paint, etc.).
   4. Painted surfaces shall be considered unacceptable if any of the following are evident under natural lighting source for exterior surfaces and final lighting source (including daylight) for interior surfaces:
      a. Visible defects are evident on surfaces when viewed at normal viewing angles from a distance of not less than 39 inches.
      b. Visible defects are evident on ceiling, soffit and other overhead surfaces when viewed at normal viewing angles.
      c. When the final coat on any surface exhibits a lack of uniformity of color, sheen, texture, and hiding across full surface area.

3.06 REPAIRS

A. Touchup Painting: After installation, promptly clean, prepare, and repaint damage to painted surfaces caused by construction operations.

B. Painted surfaces rejected by the inspector shall be repaired at the expense of the Contractor.
   1. Small affected areas may be touched up.
   2. Large affected areas and areas without sufficient dry film thickness of paint shall be repainted.
3. Runs, sags, and damaged paint shall be removed by scraper or by sanding prior to re-application of paint.

3.07 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Promptly remove spilled, splashed, or spattered coatings. After completing paint application, clean remaining spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Clean paint from finished surfaces using cleaning agents and methods which will not damage materials. Do not scratch or damage adjacent finished surfaces.

   1. If completed construction is damaged beyond normal cleaning or repair by painting operations, replace damaged items at no additional cost to Owner.

C. Clean equipment and dispose of wash water, cleaning solvents, and other cleaning and protective materials (e.g. rags, drop cloths, masking papers, etc.), paint removers / strippers, paints, and thinners in accordance with safety requirements of authorities having jurisdiction.

D. Waste Management: Per Div. 01 Section "CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL."

   1. Treat paint and related materials (thinners, solvents, etc.) as hazardous waste and dispose of in an appropriate manner.

3.08 PROTECTION

A. Provide "Wet Paint" signs and other methods to protect newly coated surfaces. Remove when directed or when no longer needed.

B. 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.

C. At completion of construction activities of other trades and immediately prior to Substantial Completion, perform detailed inspection of painted surfaces and touch up and restore damaged or defaced painted surfaces.

3.09 ATTACHMENTS

A. PAINT SYSTEMS SCHEDULE for areas of application by new substrate and MPI paint system.

B. MPI PAINT PRODUCT NUMBER SCHEDULE for MPI paint types by number and description.
# Paint Systems Schedule

## Exterior Surfaces

### Structural Steel and Metal Fabrications

<table>
<thead>
<tr>
<th>Surface</th>
<th>MPI System</th>
<th>Coating System Description</th>
<th>Gloss Level</th>
<th>Vehicle</th>
<th>Coat 1</th>
<th>Coat 2</th>
<th>Coat 3</th>
<th>Coat 4</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXT 5.1L</td>
<td>Polyurethane, pigmented (over inorganic zinc primer and high build epoxy)</td>
<td>G6 - Gloss</td>
<td>Polyurethane</td>
<td>19</td>
<td>108</td>
<td>72</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXT 5.3D</td>
<td>Polyurethane, Pigmented (over vinyl wash and epoxy primer) (high contact/traffic)</td>
<td>G6 - Gloss</td>
<td>Polyurethane</td>
<td>80</td>
<td>101</td>
<td>72</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Galvanized Metal (not chromate passivated)

- EXT 5.1L: Polyurethane, pigmented (over inorganic zinc primer and high build epoxy) - G6 - Gloss, Polyurethane - Coat 1: 19, Coat 2: 108, Coat 3: 72, Coat 4: 72
- EXT 5.3D: Polyurethane, Pigmented (over vinyl wash and epoxy primer) (high contact/traffic) - G6 - Gloss, Polyurethane - Coat 1: 80, Coat 2: 101, Coat 3: 72, Coat 4: 72

## Interior Surfaces

### Concrete Masonry Units (smooth and split face block and brick)

<table>
<thead>
<tr>
<th>Surface</th>
<th>MPI System</th>
<th>Coating System Description</th>
<th>Gloss Level</th>
<th>Vehicle</th>
<th>Coat 1</th>
<th>Coat 2</th>
<th>Coat 3</th>
<th>Coat 4</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT 4.2E</td>
<td>Institutional low odor / low VOC</td>
<td>G5 - Semi</td>
<td>Latex</td>
<td>4</td>
<td>147</td>
<td>147</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT 4.2G</td>
<td>Epoxy (tile-like) [for wet environments]</td>
<td>G6 - Gloss</td>
<td>Epoxy</td>
<td>116</td>
<td>77</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Structural Steel and Metal Fabrications (columns, beams, joists, etc.)


### Galvanized Metal (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etc.)


### Dressed Lumber (including doors, door and window frames, casings, molding, etc.)


### Plaster and Gypsum Board (gypsum wallboard, drywall, "sheet rock type material", etc., and textured finishes)


## Notes

- **General**: If selected manufacture does not have an MPI evaluated product listed in the Paint Products Schedule, submit manufacturer's recommended alternate product for approval.
- **General**: If gloss level is not scheduled on Room Schedule or Code Schedule or elsewhere on Drawings, verify required gloss level with Architect prior to or as part of submittal process.

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END OF SCHEDULE 09 91 00 13

C:/Dropbox (ABA)/_Specifications_Projects/2022/2022.514 DPSCD PS1/04 Specs/2022-06-09-%R & 06-16 100%(09 91 00 13 wsx paint systems products schedule.xlsx)\PAINT SYSTEMS SCHEDULE
# MPI PAINT PRODUCT NUMBER SCHEDULE

<table>
<thead>
<tr>
<th>MPI #</th>
<th>Category Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Block Filler, Latex, Interior/Exterior</td>
</tr>
<tr>
<td>19</td>
<td>Primer, Zinc Rich, Inorganic</td>
</tr>
<tr>
<td>39</td>
<td>Primer, Latex, for Interior Wood</td>
</tr>
<tr>
<td>50</td>
<td>Primer Sealer, Latex, Interior</td>
</tr>
<tr>
<td>72</td>
<td>Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)</td>
</tr>
<tr>
<td>77</td>
<td>Epoxy, Gloss</td>
</tr>
<tr>
<td>80</td>
<td>Primer, Vinyl Wash</td>
</tr>
<tr>
<td>101</td>
<td>Primer, Epoxy, Anti-Corrosive, for Metal</td>
</tr>
<tr>
<td>107</td>
<td>Primer, Rust-Inhibitive, Water Based</td>
</tr>
<tr>
<td>108</td>
<td>Epoxy, High Build, Low Gloss</td>
</tr>
<tr>
<td>116</td>
<td>Block Filler, Epoxy</td>
</tr>
<tr>
<td>134</td>
<td>Primer, Galvanized, Water Based</td>
</tr>
<tr>
<td>145</td>
<td>Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)</td>
</tr>
<tr>
<td>147</td>
<td>Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (MPI Gloss Level 5)</td>
</tr>
<tr>
<td>148</td>
<td>Latex, Interior, Institutional Low Odor/VOC, Gloss (MPI Gloss Level 6)</td>
</tr>
<tr>
<td>149</td>
<td>Primer Sealer, Interior, Institutional Low Odor/VOC</td>
</tr>
</tbody>
</table>

END OF SCHEDULE 09 91 00.15
SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Dimensional characters (letters and numbers, and logos).
   2. Panel signs.
   3. Field-applied, vinyl-character signs.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicating sign styles, font, foreground and background colors, overall dimensions of each sign.

B. Shop Drawings: Include plan drawings show location layout of each sign type keyed to Sign Schedule.
   1. Show elevations of each type of sign, dimensions, mounting heights, shape and thickness of materials, and details of construction and accessories.
   2. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least quarter size.
   3. Include fabrication and installation details and methods of mounting or anchoring.

C. Samples: For each sign type and color, exposed components, and exposed finishes for verification.
   1. Samples Required:
      a. Include representative samples of indicated typestyles and graphic symbols.
      c. Room and Door Signs: Full size with text and graphics, including raised characters and Braille.
   2. Approved full-size sign samples will be returned to Contractor for use in Project, provided each sample is identified and location recorded.

D. Sign Schedule: Submit in electronic spreadsheet format. Provide information sufficient to completely define each sign for fabrication, including type of sign, size, message (room number, room name, and other text to be applied), pictograms and other graphics, tactile or not, Braille, letter sizes, fonts, and colors.
1. Use room names and numbers and other text and graphics as directed by Owner. Room names and numbers for signs will be reviewed and approved by the Owner during the Shop Drawing phase, and prior to fabrication. Request such information from Owner through Architect and advise of date information is required to avoid delaying the Project. When room numbers to appear on signs differ from those on the Drawings, include both on schedule clearly differentiated.

1.05 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."

B. Package signs as required to prevent damage before installation.

C. Package room and door signs in sequential order of installation, labeled by floor or building.

D. Store tape adhesive at normal room temperature.

1.03 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 5 year warranty providing coverage against failures in materials or workmanship. Failures include, but are not limited to, the following:
   1. Deterioration of finishes beyond normal weathering.
   2. Deterioration of embedded graphic image.
   3. Separation or delamination of sheet materials and components.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.

B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS, GENERAL

A. Comparable products by other manufacturers not listed herein will be considered.

2.03 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:
   1. Accessibility Requirements: Comply with applicable provisions in ADA Accessibility Guidelines (ADAAG) and ICC A117.1 for signs.
2.04 DIMENSIONAL CHARACTERS

A. Cast Metal Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
   1. Manufacturers:
      b. Gemini Inc.
      d. Innovative Signs Inc.
      e. Matthews International Co.
      f. United States Bronze Sign Co.
      g. Wagner Foundry, Inc.
   2. Character Material: Cast aluminum.
   3. Character Height: As indicated on Drawings.
   4. Thickness: Manufacturer's standard for size of character.

2.05 PANEL SIGNS

A. Flat Panel Sign Manufacturers:
   1. 2/90 Sign Systems.
   2. Alpha Dog ADA Signs.
   3. APCO Graphics.
   4. ASI Sign Systems, Inc.
   5. Best Sign Systems, Inc.
   6. Inpro.

B. Interior and Exterior Room and Door Signs: Provide a sign for every door opening to permanent rooms and spaces. Include doorway openings without doors. Exclude corridors, lobbies, and similar open areas, unless otherwise indicated.
   1. Sign Type and Size: Match existing.
   2. Content: As scheduled and approved on Submittals.
      c. Braille: Fully domed, Grade II Braille dots set into surface or direct, UV/LED-cured, 3D-printing.
         1) Braille Dot Color: Clear.

C. Interior and Exterior Directional and Informational Signs: Provide signage to direct traffic to major entrances and areas of building.
   1. Sign Type and Size: Match existing.
   2. Where suspended, ceiling mounted, or projecting from wall signs are indicated, provide two-sided signs with same information on both sides.

D. Panel Sign Mounting Methods: Match existing.

2.06 VINYL-CHARACTER SIGNS

A. Manufacturers:
   1. APCO Graphics.
   2. Inpro.
5. Seton Identification Products.

B. Field-Applied, Vinyl-Character Signs: Prespaced characters die cut from 3- to 3.5-mil thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.
   1. Size: Match panel sign text size.
   2. Substrate: Glass.
   3. Text: As scheduled.

2.07 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
   1. Use concealed fasteners and anchors.
   2. For exterior exposure, furnish stainless-steel devices.
   3. Sign Mounting Fasteners:
      a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
      b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
   4. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Adhesive: As recommended by adhesive and sign manufacturers for intended application.

C. Wall Brackets: Manufacturer's standard extruded aluminum brackets, fittings, and hardware as appropriate for mounting signs that project at right angles from walls and to suit sign construction and mounting conditions indicated.

2.08 FABRICATION, GENERAL

A. Provide manufacturer's standard sign assemblies according to requirements indicated.

2.09 DIMENSIONAL CHARACTER FABRICATION

A. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.10 PANEL SIGN FABRICATION

A. Fabricate panel signs to comply with the requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally.

B. Laminated Panels: Permanently laminate face panels to backing sheets using manufacturer's standard process.

C. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.

2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.

3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. Subsequent changeable sign panels are by Owner.

2.11 METAL FINISH REQUIREMENTS

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

B. Aluminum Finish:
1. Superior-Performance Organic Finish: AAMA 2605 PVDF fluoropolymer superior performing coating per Div. 05 Section "SHOP-APPLIED PAINT COATINGS FOR METAL."

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Verification of Conditions:
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
3. Verify that sign substrate surfaces are clean and free of materials or debris that would impair installation.
4. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

C. Verify sign locations indicated on Drawings and accessibility requirements do not conflict. Notify Architect of conflicts and obtain direction before proceeding.

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

3.02 SCHEDULE

A. Develop sign schedule and layout in cooperation with Owner and Architect.

3.03 INSTALLATION

A. Comply with manufacturer’s written installation instructions and recommendations and approved submittals.
1. Install signs using mounting methods indicated.
2. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
3. Install signs so they do not protrude or obstruct according to the accessibility standard.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Accessible Signage with Tactile Characters: Install in locations indicated or, if not indicated, in accordance with accessibility requirements. If sign locations are not indicated, obtain Architect's approval of locations before installation.

C. Exterior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.

D. Mounting Methods:
   1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
      a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
      b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
   2. Shim-Plate Mounting: Provide concealed shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using mounting method specified above.


F. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.04 REPAIR

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.05 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 00
SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes commercial accessories for toilet rooms.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct at Project site per Div. 01 Section "PROJECT MEETINGS" minimum one week prior to commencing work of this Section.

B. Coordination: Per Div. 01 Section "PROJECT COORDINATION" and as follows:
1. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
2. Coordinate installation of proper structural backing in walls and partitions to support wall mounted accessories.

1.03 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES,"

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include the following:
1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Identify features and options that will be included for Project.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicate types, quantities, sizes, and installation locations by room of each accessory required.
1. Identify locations using room designations indicated on Drawings.
2. Identify accessories using item designations indicated on Schedule.

1.05 INFORMATIONAL SUBMITTALS

A. Sample warranties.
1.06 CLOSEOUT SUBMITTALS
   
A. Operation and Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."

B. Executed warranties per Div. 01 Section "WARRANTIES."

1.07 MAINTENANCE MATERIALS
   
A. Tools: Furnish special wrenches, tools, keys, and other devices supplied by product manufacturer for Owner to maintain accessories.
   1. Furnish minimum of 6 keys of each type required to service accessories.

1.06 DELIVERY, STORAGE, AND HANDLING
   
A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
   1. Retain strippable protective covering on stainless steel finishes prior to installation.

1.07 WARRANTY
   
A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."

B. Standard Warranty: Furnish manufacturer's standard 15 year mirror warranty providing coverage against visible silver spoilage defects or that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
   
A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS
   
A. Manufacturers:
   1. Commercial Toilet Accessory Manufacturers:
      a. AJW.
      b. American Specialties, Inc.
      c. Bobrick Washroom Equipment, Inc.
      d. Bradley Corporation.
      e. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
      f. Tubular Specialties Manufacturing, Inc.
   2. Underlavatory Guard Manufacturers:
      a. Keeney Manufacturing Co.
      b. Oatey Co.
      c. Plumberex Specialty Products, Inc.
      d. Truebro by IPS Corporation.

B. Basis-of-Design Products: As scheduled on Drawings.

C. Source Limitations: Provide products of same manufacturer for each type of accessory unit for entire Project, unless otherwise approved by Architect.
2.03 DESCRIPTION

A. Product Options: Accessories scheduled establish requirements for aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines and to one another. Performance characteristics are indicated by criteria subject to verification by in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

B. Regulatory Requirements:
   1. Accessibility Requirements: Comply with applicable provisions in ADA Accessibility Guidelines (ADAAG) and ICC A117.1.

2.04 PERFORMANCE CRITERIA

A. Operational Requirements:
   1. Provide units with operational controls which are operable with one hand and which do not require tight grasping, pinching, or twisting of the wrist.
   2. Force required to operate push buttons, knobs, pistons, hinged panels, and other operable elements shall be no greater than 5 lb.

B. Structural Requirements: Allowable stresses in bending, shear, and tension shall not be exceeded for materials used when a vertical or horizontal force of 250 lb is applied at any point on grab bars, fastener mounting devices, or supporting structure.

2.05 MANUFACTURED UNITS

A. See Toilet Accessories Schedule for Basis of Design product listing.

2.06 MATERIALS

A. Stainless Steel:
   1. Sheet: ASTM A666, Type 304, 0.031 inch minimum nominal thickness, unless otherwise indicated.
   2. Tubing: ASTM A269/A269M, Type 304.

B. Galvanized-Steel:

C. Mirrors: ASTM C 1503, Mirror Select Quality, clear, nominal 5 mm thick annealed and backed with safety film to comply with ANSI Z97.1 for Category II.


E. Fasteners: Screws, bolts, and other devices appropriate to substrate indicated and recommended by unit manufacturer. Provide tamper-and-theft resistant type, of same material as accessory unit, for exposed fasteners. Provide galvanized steel for concealed fasteners.

F. Bituminous Coating: ASTM D 1187 cold-applied asphalt emulsion or ASTM D4479, Type I asphalt roof coating.
2.07 FABRICATION

A. Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Manufacturer's Product Identification: One, maximum 1-1/2-inch diameter, unobtrusive stamped manufacturer logo is permitted on exposed face of accessories.
   1. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

C. Provide universal keys for internal access to accessories for servicing and resupplying.

2.08 FINISHES

A. Stainless Steel Sheet Finish: Per ASTM A480 as follows:
   1. No. 4 Polished Finish - General purpose polished finish.
   2. 

B. Chrome/Nickel Plating: ASTM B 456, Service Condition Number SC 2 (moderate service); satin finish.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

B. Verification of Conditions:
   C. Verify blocking has been installed properly. Verify location does not interfere with door swings or use of fixtures. Deliver inserts and rough-in frames to site for timely installation.

D. Provide templates and rough-in measurements as required.

E. Where sheet metal contacts ferrous metal or other corrosive substrates, coat contact surfaces of sheet metal with bituminous coating.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Install units level, plumb, and firmly anchored in locations and at heights indicated.

C. Mirrors: Secure to walls with concealed special hangers with tamper-resistant attachment.

D. Grab Bars: Install per ASTM F 446.

E. Mounting Heights and Locations for Accessories: Per ADA Standards.

F. Fill dispensers with appropriate product prior to Substantial Completion.
G. Test for proper operation.

3.03 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Conceal evidence of drilling, cutting, and fitting to room finish.

C. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces per manufacturer's written recommendations.

END OF SECTION 10 28 00
SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Manually operated roller shades with single rollers.

B. Related Requirements:
   1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
   2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
   3. Div. 06 Section "MISCELLANEOUS ROUGH CARPENTRY" for wood blocking and grounds for mounting roller shades and accessories.

1.02 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each type and color of exposed products for verification.
   1. Sample Size:
      a. 12 inches in length for linear materials.
      b. 12 inches square for shadeband materials.
      c. Full size for installation accessories.
   2. Shadeband material. Mark inside face of material if applicable.
   3. Installation accessories involving color selection.

D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

A. Certificates: Per Div. 01 Section "SUBMITTAL PROCEDURES" and as follows:
   1. Product certificates for each type of shadeband material, signed by product manufacturer.

B. Test and Evaluation Reports: As follows:
   1. Product test reports for each type of shadeband material.

C. Sample warranties.
1.05 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance data per Div. 01 Section "OPERATION AND MAINTENANCE DATA."
   B. Executed warranties per Div. 01 Section "CLOSEOUT PROCEDURES."

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Per Div. 01 Section "PRODUCT REQUIREMENTS" and as follows:
      1. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.05 FIELD CONDITIONS
   A. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
      1. Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.06 WARRANTY
   A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."
   B. Standard Warranty: Furnish manufacturer's standard warranty providing coverage against failures in materials or workmanship as follows:
      1. Warranty Periods:
         a. Manual Shades: Manufacturer's standard but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS
   A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products.
   B. See Div. 01 Section "PRODUCT REQUIREMENTS" for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 MANUFACTURERS
   A. Manufacturers:
      1. Draper Inc.
      3. Lutron Electronics Co., Inc.
      4. MechoShade Systems, Inc.
      5. Silent Gliss USA, Inc.
      6. Comparable products by other manufacturers will be considered.
   B. Source Limitations: Obtain roller shades from single source from single manufacturer.
2.03 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Basis-of-Design Product: Mecho/5 by MechoShade Systems, Inc. or a comparable product by one of the other listed manufacturers.

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
      a. Loop Length: No more than 40 percent of roller shade height.
      b. Limit Stops: Provide upper and lower ball stops.
      c. Chain-Retainer Type: Chain tensioner, jamb mounted, two per length of chain.
      a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criteria are more stringent.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
   1. Roller Drive-End Location: Manufacturer's standard.
   2. Direction of Shadeband Roll: Regular, from back of roller.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

F. Shadebands:
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: Enclosed in sealed pocket of shadeband material.
      b. Color and Finish: As selected by Architect from manufacturer's full range.

G. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
      a. Shape: L-shaped.
      b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 3 inches.
   2. Endcap Covers: To cover exposed endcaps.
   3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.04 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
   2. Roll Width: As required to eliminate or minimize vertical seams.
   3. Orientation on Shadeband: Up the bolt.
2.05 ROLLER-SHADE FABRICATION

A. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

C. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
   2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

D. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
   1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION" and as follows:

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.

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

3.02 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
   1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.03 ADJUSTING

A. Per Div. 01 Section "EXECUTION" and as follows:
B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:

B. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

3.05 PROTECTION

A. Per Div. 01 Section "EXECUTION" and as follows:

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 12 24 13
SECTION 12 36 00 - COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes shop-fabricated countertops for the following uses:
1. Architectural cabinet work.

B. Related Requirements:
1. Contracting Requirements of Div. 00 Documents apply to, and are a component part of, this Section.
2. General Requirements of Div. 01 Specification Sections apply to, and are a component part of, this Section.
3. Div. 06 Section "ARCHITECTURAL WOOD CASEWORK."

1.02 SUBMITTALS, GENERAL

A. Process and transmit per Div. 01 Section "SUBMITTAL PROCEDURES."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Complete details of materials and installation. Combine with shop drawings of cabinets and casework specified in other sections.
1. For each countertop, show location, dimensioned plans and elevations, materials, finishes, seam locations.
2. Include full-size details of back and end splashes, exposed edges, and methods of joining.
3. Show details of joints.
4. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
5. Show locations and sizes of cutouts and holes for items installed in or through countertops.
6. Indicate types of sealants and adhesives.

C. Samples: For each type and color of countertop material for verification.
1. Countertop material, 6 inches square with seam or joint in center.

1.04 QUALITY ASSURANCE

A. Qualifications: Per Div. 01 Section "QUALITY REQUIREMENTS" and as follows:
1. Fabricator Qualifications: Minimum 5 years experience under current organizational structure.
   a. Company: An employer of skilled workers trained to custom fabricate countertops as required for this Project and whose products have a record of successful in-service performance.
2. Installer Qualifications: Minimum 5 years experience under current organizational structure.
1.05 DELIVERY, STORAGE, AND HANDLING

A. Per Div. 01 Section "PRODUCT REQUIREMENTS."
1. Do not deliver countertops until supporting casework has been completed.
2. If countertops must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.06 FIELD CONDITIONS

C. Ambient Conditions: Per Div. 01 Section "EXECUTION" and as follows:
1. Minimum Conditions: As required by countertop and sealant material manufacturer.

1.02 WARRANTY

A. Process and transmit per Div. 01 Section "CLOSEOUT PROCEDURES."
B. Standard Warranty: Furnish manufacturer's standard 10 year warranty providing coverage against defects in materials.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. See Div. 01 Section "PRODUCT REQUIREMENTS" for general requirements common to products and for Contractor's options when selecting Products and procedures for offering comparable products.

2.02 PERFORMANCE CRITERIA

A. Surface-Burning Characteristics: ASTM E 84; Class A. Identify products with appropriate markings of applicable testing agency.

2.03 SOLID SURFACING COUNTERTOPS

A. Configuration:
1. Laminate to nominal 3/4 inch thick wood panel subtop.
2. Solid Surface Material Thickness:
3. Front Edge: Straight, slightly eased at top, built up with same material to 1-1/2 inch edge thickness.
4. Back Edge: 4 inch high loose backsplash straight, slightly eased at top.
5. Ends at Walls: Match backsplash.
6. Open Ends: Match front edge, no splash.

B. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1 and ISFA 2-01.
   b. Hi-Macs by LG Hausys.
   c. Staron by Lotte Advanced Materials Co., LTD.
2.04 ACCESSORIES

A. Wood-Based Panels: Nominal 3/4 inch thick panels.
   1. Softwood Plywood: DOC PS 1, Grade C-C Plugged, touch sanded.

B. Adhesives:
   1. Mounting Adhesives: 100 percent silicone sealant as recommended by countertop material manufacturer.
   2. Seam Adhesive: As recommended by countertop material manufacturer to create inconspicuous, color-coordinated seams.

C. Sealant: Compatible with adjacent materials and complying with requirements in Div. 07 Section "JOINT SEALANTS."

2.05 FABRICATION

A. Prior to fabricating countertops, verify dimensions for countertops by field measurements after walls and base cabinets are installed and indicate measurements on Shop Drawings. Construct templates as required.

B. To greatest extent practical, fabricate countertops in shop to sizes and shapes indicated. Comply with approved Shop Drawings and countertop material manufacturer’s written instructions. Assemble countertops in one piece except where size availability or transportation limitations are prohibitive.
   1. Form joints between countertop components using seam adhesive with inconspicuous seams free of voids.
   2. Countertops With Subtops: Adhere top to continuous wood panel subtop using mounting adhesive.
   3. Where indicated, ease external corners and exposed edges, except sink cutouts, to 1/16 inch radius or bevel. Finish exposed cutouts for sinks to 1/4 inch radius.
   4. Cut openings in shop for plumbing fixtures, fittings, faucets, soap dispensers, waste receptacles, grommets, and other items installed in or through countertops and splashes.
      a. Rout cutouts, radii and contours to template.
      b. Rout and finish cut edges smooth and uniform without saw marks. Smooth bottoms of openings where contact is possible.
      c. Seal edges of cutouts in wood including subtops by saturating with varnish.

C. Fabrication Tolerances:
   1. Variation in Countertop Size: Plus or minus 1/8 inch in 10 feet, non-cumulative.
   2. Location of Openings: Plus or minus 1/8 inch from indicated location.
   3. Shop-Fabricated Joint Size: As small as permitted by countertop material manufacturer; plus 1/16 inch, minus zero inch.
PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Per Div. 01 Section "EXAMINATION AND PREPARATION."

3.02 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions and recommendations and approved submittals.

B. Countertops With Subtops: Fasten to casework by screwing through corner blocks of base units into underside of subtop.

C. Where field seaming is required, align adjacent surfaces and form seams with seam adhesive to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Install splashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
   1. Secure backsplashes to walls with adhesive.

E. Seal joints between countertops, including splashes, and adjacent walls per Div. 07 Section "JOINT SEALANTS."

F. Installation Tolerances:
   1. Level: 1/8 inch in 10 feet, non-cumulative.
   2. Minimum of 1/16 inch and maximum of 1/8 inch clearance between countertop and splash surfaces and adjacent walls.
   3. Field-Fabricated Joint Size: As small as permitted by countertop material manufacturer; plus 1/16 inch, minus zero inch.

3.03 REPAIR

A. Inspect installed countertops not more than 14 days prior to requesting initial inspection for Substantial Completion. Repair minor surface scratches and damage caused during installation and construction per manufacturer's written instructions.

B. Replace countertops that cannot be repaired to Architect's satisfaction.

3.04 CLEANING

A. Per Div. 01 Sections "CLOSEOUT PROCEDURES" and as follows:
   1. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.

B. Immediately after installation, clean countertops per manufacturer's written instructions.
3.05 PROTECTION

A. Per Div. 01 Section "EXECUTION."

END OF SECTION 12 36 00
SECTION 20 05 00 - COMMON WORK RESULTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

1.2 SUMMARY
A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   3. Transition fittings.
   4. Dielectric fittings.
   5. Mechanical sleeve seals.
   7. Escutcheons.
   8. Grout.
   9. Mechanical Demolition.
   10. Equipment installation requirements common to equipment sections.
   11. Painting and finishing.
   12. Concrete bases.
   14. Coordination drawings.

1.3 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for materials:
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.
   5. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.
   5. Coordination drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 SUBMITTALS

A. Welding certificates.

B. Shop drawings: Submit for all major equipment including, but not limited to the items listed in Division 20, 21, 22, 23. Submittals shall be provided in electronic format.

C. As-built Drawings: Submit as-built drawings that include accurate dimensioned record drawings of all underground work, above ground piping, and ductwork systems. As-built drawings shall be submitted in electronic format.

D. Operation and Maintenance Manuals: When the building is substantially complete and before the building is taken over by the Owner for maintenance purposes, the contractor shall provide four sets of complete operation and maintenance manuals. The manual shall consist of an
indexed loose-leaf binder containing the equipment data, manufacturer’s installation, operating, and maintenance, repair parts manual for each system component, test reports, and as-built temperature control diagrams. Refer to Divisions 20, 21, 22, and 23 for additional submittal requirements. Provide an electronic copy of the operation and maintenance manual in addition to three (3) sets of loose-leaf hard copy binders. Preliminary copy of O&M manuals shall be submitted to commissioning agent for review. Schedule of preliminary submittal will be reviewed with Commissioning Agent at the commissioning kick off meeting.

E. Substitutions: The contractors’ base bid must be in accordance with the materials or products specified. Any exceptions to this must be approved in writing by the Architect/Engineer, 10 days or more prior to bidding. Voluntary alternates may be submitted for consideration on the proposal, with listed addition or deductions to the base bid, but will not affect the awarding of the contract.

F. Coordination Drawings: Contractor shall prepare above ceiling coordination drawings for efficient installation of different components and coordination for installation of products and materials fabricated by each trade.

1. Content: Project-specific information, drawn accurately to scale, 1/4 inch per foot. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
   a. Indicate functional and spatial relationships of components of architectural, structural, mechanical, and electrical systems.
   b. Indicate required installation sequences.
   c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Sheet Size: 30 by 42 inches

3. Number of Copies: Electronic submissions are preferred. Where not feasible, provide the following.
   a. Submit two opaque copies of each submittal. Architect will return one copy.
   b. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.

4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform all Work in accordance with applicable Federal, State and local codes rules, ordinances and regulations. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standards, Rules and Regulations of NFPA, UL, and as follows unless otherwise indicated.

1. Boiler Code
2. ASHRAE 55
3. ASHRAE 62.1
4. **ASHRAE 90.1**

B. **Steel Support Welding:** Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. **Steel Pipe Welding:** Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. **Electrical Characteristics for Equipment:** Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. **Permits and inspections:** Obtain and pay for all permits (temporary and permanent), fees, and inspections as required by any applicable laws and ordinances. Post such permits and inspection Certificates in a prominent place adjacent to the work. Deliver all certificates of final inspection or approval to the Architect/Engineer. Do not cover any concealed work until final inspection has been made and approval certificates obtained.

1.8 **DELIVERY, STORAGE, HANDLING, AND INSTALLATION**

A. Deliver ductwork, pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent ductwork and pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. During installation, provide temporary caps of sufficient material to prevent entrance of dirt, debris, and moisture.

1.9 **COORDINATION**

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Under provisions of commissioning documentation; testing of mechanical equipment, as well as training of owner’s operation and maintenance personnel, shall be required in cooperation with the commissioning agent.

E. Refer to the Owner/Utility tie-in schedule.
F. Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work.

G. Each contractor shall coordinate its operations with operations, included in different sections, which 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 with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
   4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

H. Contractor shall participate in whole building information modeling coordination process utilizing a three-dimensional software platform compatible with Autodesk® Navisworks®. Contractor shall include all time associated with detailing, coordination meetings, and model generation for the BIM coordination process.

1.10 WARRANTIES

A. In the event that any part of the work or equipment fails (abuse and causes beyond control of the contractor excepted), within this period of guarantee, it shall be replaced by the contractor at no cost to the owner.

B. All mechanical system components and controls shall be provided with a minimum 1-year warranty. Specific mechanical components may have longer warranty periods. Warranty shall be unconditional and include material, labor and response with 24 hours of notification. All warranties to begin at substantial completion and extend for period indicated in the contract documents.

1.11 SYSTEM STARTUP

A. Special mechanical equipment such as boilers, rooftop units, VRF system etc., shall have initial start-up of equipment assigned to a trained manufacturer’s representative who can check and report on items such as installation, lubrication, alignment, etc., and see that the equipment starts and operates properly.

B. Activation of the heating, ventilating and air conditioning equipment for testing and balancing will be allowed only after the construction is substantially complete, or by permission of the owner’s construction representative.

C. Air handling systems used prior to final acceptance shall have specified filters installed during temporary use. Replace the temporary filters if the filters become loaded to capacity during system activation. Install replacement filters upon completion of the work and prior to final acceptance. Record the dates when the filters are changed for system start-up and when spare filters are provided with the commissioning agent documents.
1.12 MAINTENANCE

A. Contractor shall be responsible for maintenance of equipment and systems installed until final acceptance by Owner.

B. Lubricate rotating equipment in accordance with manufacturer’s recommendations before activation. Re-lubricate as required during activation and prior to final acceptance.

C. Provide readily accessible and secured copper extensions to bearing lubrication fittings on equipment bearings.

1.13 SITE INSPECTION

A. Contractor shall visit the site prior to submitting Proposal and examine and verify existing conditions. Additional charges will not be allowed due to failure to complete site visit or to include necessary materials and labor to complete the work. Proposal being submitted implies site visit has occurred and contractor understands the conditions which the work will be conducted.

1.14 CONSTRUCTION DOCUMENT INTERPRETATION

A. Any conflict within the documents shall be included with the highest cost.

1.15 TESTING, ADJUSTING AND BALANCING MOTOR PULLEY REQUIREMENTS

A. For all constant speed belt driven fans greater than 5 hp, Contractor shall provide and install two sets of fixed motor pulleys. First set shall be installed for initial start-up and shall be based on scheduled data. Factory provided motor pulley may be used if properly sized. The second set shall be installed after system balance is complete and shall be based on actual field conditions as determined by the TAB contractor.

B. For all constant speed belt driven fans through 5 hp, Contractor shall provide and install two sets of adjustable motor pulleys. First set shall be installed for initial start-up and shall be based on scheduled data. Factory provided motor pulley may be used if properly sized. The second set shall be installed after the balance is complete and shall be based on actual field conditions as determined by the TAB contractor. Select motor pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

C. For all belt driven variable frequency drive operated fans, contractor shall provide and install one set of fixed motor pulleys sized to allow full utilization of fan motor horsepower provided, with VFD at 100 percent of fan motor RPM

D. Furnish motor pulleys of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 ACCESS DOORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Larson.
   2. Milcor.
B. Access doors in walls or ceilings shall be of 24”X24” in size, unless specified otherwise or space restricted.
C. Non-labeled door shall be 16-gauge prime painted steel frame; 14-gauge prime painted steel panel; concealed spring type hinges; and flush, screwdriver operated metal cam lock.
D. Labeled doors shall be UL listed; 16-gauge, prime painted steel frame; sandwich type with 20-gauge face sheets, flush design with filler panels; continuous hinges with stainless steel pins and flush, self-latching cylinder locks with two keys per lock. Coordinate doors and accessories with Division 08 Section 08 31 13 “ACCESS DOORS AND FRAMES”.
E. All access doors shall have flush mounted handles.

2.3 PIPE, TUBE, AND FITTINGS
A. Refer to individual Division 21, 22, and 23 piping sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS
A. Refer to individual Division 21, 22, and 23 piping sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless
thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8-inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.5 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

   1. Manufacturers:
      b. Dresser Industries.
      c. Ford Meter Box Company.
      d. JCM Industries.
      e. Smith-Blair.
      f. Viking Johnson.

   2. Underground Piping: Manufactured fitting or coupling.

   3. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer’s Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

   1. Manufacturers:
      a. Eslon Thermoplastics.
C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. Nibco.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse.
      d. Epco Sales.
      e. Hart Industries.
      f. Watts.
      g. Zurn Industries.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales.
      d. Watts.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      b. Calpico.
c. Central Plastics Company.
d. Pipeline Seal and Insulator.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico.
      b. Lochinvar.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products.
      c. Sioux Chief Manufacturing Co.
      d. Victaulic Company.

2.7 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Advance Products & Systems.
   2. Flexicraft Pipeseal.
   3. Calpico.
   5. Pipeline Seal and Insulator.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Glass reinforced plastic. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. GPT; an EnPro Industries company.
B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.9 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Description: Manufactured, galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.10 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems.
   2. Airex Manufacturing.
   3. CALPICO.
   4. GPT; an EnPro Industries company.
   5. Metraflex Company.
   6. Proco Products.

B. Description:
   1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve. Designed to form a hydrostatic seal of 20-psig.
   2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
   3. Pressure Plates: Stainless steel
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.11 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Presealed Systems.
6. Proco Products, Inc.

B. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.12 ESCUTCHEONS

A. Description: Manufactured chrome plated wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

E. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.13 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange [with holes for fasteners].

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.14 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.15 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. GE Construction Sealants; Momentive Performance Materials Inc.
   b. Pecora Corporation.
   c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
   d. Polymeric Systems, Inc.
   e. Sherwin-Williams Company (The).
   f. The Dow Chemical Company.

2. Sealant shall have a VOC content of 250 g/L or less.

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

2. Sealant shall have a VOC content of 250 g/L or less.

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

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

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Smooth-On.

2. Sealant shall have a VOC content of 250 g/L or less.

3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Sections "Selective Demolition" and "Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove Fire Protection systems, HVAC systems, Plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment
operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 WORK IN EXISTING BUILDINGS

A. Access to the existing building will be provided by the owner as required and a project schedule will identify access requirements to occupied buildings. Work shall be completed by the Contractor without interruption once Work has begun to facilitate returning the areas of work back to the Owner as soon as possible.

B. Provide adequate protection of all existing and newly installed Work. Contractor shall promptly repair any damage to new or existing Work at Contractor’s expense.

C. Contractor shall consult with the Owner on methods of performing Work so the Owner’s operation is not disrupted more than absolutely necessary. The Owner shall designate when interruption of existing services may occur. Contractor shall leave all services in operation until such time.

D. All items and equipment removed as part of the demolition process shall remain property of the owner unless possession rights are waived. Contractor shall meet with Owner prior to start of demolition to determine which items are to be salvaged. Contractor shall remove remaining items from the site.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22, 23 sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping indicated to be exposed in finished areas as high as possible unless noted otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping to permit valve servicing. Valves shall be located not more than 24 inches above the suspended ceiling grid.
H. Install piping at indicated slopes.

I. Install piping free of sags and bends. Piping shall be installed level and plumb where piping slopes are not required.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Install escutcheons for penetrations of walls, ceilings, and floors:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
      e. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.
      f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

O. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsumboard partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces of walls.
      a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Schedule 40 Black Steel Sleeves: For pipes penetrating interior walls.
      b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
4. Seal sleeves in concrete floors, roof slabs, and masonry walls with grout.
5. Seal sleeves in plaster/gypsum board partitions with plaster or drywall compound and caulk with non-hardening silicone sealant to provide airtight installation.
6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section “Joint Sealants” for materials and installation.
7. Sleeves through floors and walls shall be sized so that the required pipe insulation is continuous through the sleeve.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves of all sizes.
   2. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section “Penetration Firestopping” for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

T. Contractor shall maintain adequate clearances (per the latest edition of the national electric code) above and around any new electrical panels, equipment, and transformers when routing overhead piping.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22, and 23 sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA’s “Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

J. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

1. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

2. PVC Non-pressure Piping: Join according to ASTM D 2855.

K. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

L. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each control valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 larger, adjacent to each control valve and at final connection to each piece of equipment.

3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated or coordination with other services dictates different mounting heights.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC and Plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.
3.7 ACCESS DOOR INSTALLATION

A. Access doors shall be provided in all pipe chases, soffits, walls, ceilings, and ductwork to give access to valves, dampers, both sides of booster coils in ductwork or VAV terminals, control devices, etc.

B. All access doors shall be within 24 inches of any fire damper.

C. Coordinate the exact location with other trades.

D. Verify the exact quantity, size and location of the required access panels after the installation of systems and equipment requiring access, and prior to the closure of affected ceilings and building assemblies.

3.8 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09 Section 09 91 00 "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."

B. Provide concrete bases where specified within individual products' specifications and/or where indicated on the drawings and details.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section 05 00 00 "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
   1. Provide all supplementary steel to provide proper drainage for gravity flow systems.

C. Field Welding: Comply with AWS D1.1.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 GROUTING
A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 20 05 00
SECTION 20 05 13 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation.

B. Related Sections include the following:

1. Section 20 05 14 "Variable Frequency Drives".
2. Section 26 28 13 "Fuses".
3. Section 26 28 16 "Enclosed Switches and Circuit Breakers".
4. Section 26 28 16 "Enclosed Controllers".

1.3 DEFINITIONS


B. IEEE: Institute of Electrical and Electronics Engineers.


D. MG 1: (NEMA) Motors and Generators Standard.

E. VFD: Variable frequency drive.

1.4 SUBMITTALS

A. Submit the following product data for approval:
1. Manufacturer information.
2. Dimensions and elevations.
3. Complete NEMA nameplate electrical data including design type, insulation, service factor, and efficiency.
   1) Bearing type, L10 bearing life, and seal construction (open, single, or double shielded).
5. Certification that VFD driven motors comply with all parts of NEMA MG-1 Part 31.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Baldor Electric Company
   2. Dayton.
   4. Leeson Electric.
   5. Marathon Electric.
   7. Toshiba Corporation.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in Fire Protection, Plumbing or HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.
C. Comply with ABMA 9 for bearing life calculations. For belted applications, calculations shall be based on maximum external side load limits per NEMA MG 1 Table 14-1A. L10 life calculations for vertical motors and horizontal motors mounted in the vertical position shall consider the application’s thrust loading.

2.3 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level. Maximum hot spot temperature shall not exceed the insulation temperature limit, when operated in an ambient temperature of 104 deg F, except as otherwise indicated.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Noise: Motors shall not exceed dBA levels listed in NEMA MG 1 section 12.54 at all speeds.

2.4 POLYPHASE MOTORS (1/2 HP and larger)

A. Description: NEMA MG 1, Design B, squirrel cage, medium induction motor with open drip proof enclosure unless noted otherwise in equipment specifications of schedules. When totally enclosed fan cooled motors are specified or scheduled, provide external shaft slinger on drive end.

B. Efficiency: Nominal (nameplate) full load efficiency and corresponding minimum efficiency equal to or greater than that stated in NEMA MG 1 Table 12-12 – Premium Efficient Motors Nominal Full Load Efficiencies.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors smaller than 15 HP: Manufacturer’s standard starting characteristic.

J. Enclosure Material and Bearings:
1. Motors less than 3 HP: Steel or cast iron motor frames, cast aluminum, cast iron, or steel end plates, steel or cast iron terminal box, copper windings.
   a. Bearings shall be regreaseable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings, selected for a minimum L10 bearing life of 26,280 hours, for belted and direct drive.

2. Motors 3 HP and above: Cast iron motor frames and mounting feet, cast iron end plates (bells), steel or cast iron terminal box, copper windings.
   a. Bearings shall be regreaseable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings. Rated for a minimum L10 bearing life of 40,000 hours for belted or 130,000 hours for direct drive.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Inverter-Duty Motors: Class B temperature rise; Class H insulation.
   3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   4. Provide a maintenance free, circumferential conductive micro-fiber ground ring installed on the motor to discharge stray shaft currents to ground. Grounding ring shall be AEGIS SGR (shaft grounding ring). Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer’s motor warranty from induced current bearing damage.
   5. Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer’s motor warranty from induced current bearing damage.

2.6 SINGLE-PHASE MOTORS (less than 1/2 HP)

A. Motors larger than 1/20 HP shall be one permanent-split-capacitor type, to suit starting torque and requirements of specific motor application:

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
F. Furnish with sliding base/slotted mounting holes adequate for proper belt tensioning and alignment of motor or motor/load.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and align motors in accordance with the equipment manufacturer’s recommendations.

B. For VFD driven motors using a shaft grounding ring: Install grounding ring in accordance with the manufacturer’s recommendations, including application of a colloidal silver shaft coating on the motor shaft.

3.2 COMMISSIONING

A. Perform commissioning activities as outlined in Division 1 Section, Commissioning Requirements, and other requirements of the Contract Documents.

3.3 ADJUSTING, CLEANING, PROTECTION

A. Assure motor nameplate is legible and properly affixed.

B. Verify bearings are factory lubricated before starting motors. Lubricate per manufacturer’s instructions. Do not over lubricate bearings.

C. Check motors for unusual heating, noise, or excessive vibration during operation. Correct any such deficiencies.
   1. Any motors with vibration exceeding specified limits, as noted in the Testing, Adjusting, and Balancing Section, or manufacturer’s recommendations, whichever is more stringent, shall be corrected, at no cost to the Owner, until reduced below those limits.

D. Clean the motor prior to start-up and immediately prior to final turn-over to the Owner.

END OF SECTION 20 05 13
SECTION 20 05 14 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 DEFINITIONS


C. IEEE: Institute of Electrical and Electronics Engineers.

D. NEMA: National Electrical manufacturer’s Association.

E. UL: Underwriters Laboratory.

F. VFD: Variable Frequency Drive.

1.3 SUBMITTALS

A. Product Data: Include dimensions and elevations, complete product data listing all included features, electrical rating for each VFD, matched to each piece of driven equipment, and fault current rating.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.


   a. Line/load connection points.

   b. Main input and inverter input disconnect switches.

   c. VFD/bypass switch circuit.

   d. Fusing/circuit breakers.

   e. Auxiliary control transformer.
f. Local/remote circuit.
g. Hand-off-auto circuit.
h. Safety interlock, run permissive, and drive initiated external circuits.
i. Analog inputs and outputs.
j. Pilot lights.
k. Each wire on the wiring diagram shall be labeled with a distinct wire identifier.

2. VFD panel face diagram indicating the location of the main and inverter disconnect switches, local/remote and H-O-A switches, VFD/bypass switch, pilot lights, digital display, keypad, programmable carrier frequency limitations (4-5 kHz or 2-14 kHz) and any other face mounted device, along with the panel face labeling.

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. VFD shall comply with NFPA 90 (National Electrical Code), IEEE 519, UL 508, and FCC compliance for Radio Frequency Interference (RFI) and Electro-Mechanical Interference (EMI).

B. Unit shall be UL listed, as an entire assembly, and bear the UL label.

C. All circuit boards shall be completely tested and burned-in prior to assembly into the completed VFD.

D. Factory test complete VFD to ANSI/UL Standard 508. Functionally test all options, perform dynamometer test at full load, cycle load and speed during factory test.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A.B.B.
2. Danfoss.
3. Yaskawa Electric America.
2.2 GENERAL

A. Unit shall be dead front construction.

B. All relays shall be a plug-in style base.

C. All fuses shall be mounted in fuse blocks with insulated covers. Covers shall shield fuse ends and wire terminations.

D. The VFD shall be marked with its short circuit current rating in compliance with UL.

E. The unit, including all specified accessories, shall have a minimum efficiency of 85% at any speed from 50 to 100%. The unit shall have a power factor of 0.9 or higher when operating at any speed from 50 to 100%.

F. The VFD shall be a variable torque type and shall provide full motor torque at any operating speed from 40 to 100%.

G. The VFD shall provide variable torque V/Hz control when operating at speeds less than 100%.

H. The VFD must be capable of operating in the following service conditions:
   1. Ambient Temperature: 0º to 40ºC (32º to 104ºF).
   2. Relative Humidity: 0 to 95%, non-condensing.
   3. Elevation: 0 to 3300 ft. (100 meters) above mean sea level (MSL).
   4. AC line voltage variation:
      a. 480 V: 440 - 10% to 500 + 10%; 45-65 Hz
      b. 230 V: 200 - 10% to 230 + 10%; 45-65 Hz

I. Provide the drive with a main input disconnect switch, accessible without opening the drive cabinet, equipped with current limiting fuses and fuse rejection clips, or circuit breakers. All other fuse blocks with current limiting fuses installed shall be equipped with fuse rejection clips. It shall be possible to padlock the disconnect in the “off” position.

J. Provide minimum 6 pulse-width modulation (PWM) type drives.

K. Provide the necessary electronics to avoid audible noise generated from the motor due to frequency change. The unit shall not increase the motor audible noise by more than 3 dB above the motor’s across-the-line noise at any motor speed from 50 to 100%.

L. The unit shall include self-diagnostics with a digital display that identifies fault conditions and trouble shooting. Fault indication shall be retained even after a power outage or an input over-current protective device trip.

M. Unit shall be provided with RFI/EMI filters.

N. VFD shall include current sensors on all three output phases to accurately measure motor current.
O. Provide minimum 3% AC input line reactors and/or minimum 5% DC link reactors to limit the maximum current total harmonic distortion (THD) to not more than 100% of the variable frequency drive (VFD) input current waveform at any VSD operating speed from 20 to 100%. Reactors shall be integral to the VFD. The reactors shall not be active when the drive is in the bypass mode. If testing reveals the maximum THD is exceeded, the manufacturer shall provide and install additional reactors at no cost to reduce the THD to within these specified limits.

P. The unit shall have a dedicated terminal block for all external inputs and outputs.

Q. Provide a factory mounted and wired 115 V, 1 Ph, 60 Hz control power transformer sized for handling an additional 30 VA inductive load. Limit fuse size for the control transformer to 3 amps maximum.

R. The VFD input and output shall be rated at 480-volt, 3 phase or 208-volt, 3 phase.

S. The VFD shall have a minimum short circuit current rating (SCCR) of 100 kA.

T. Provide a factory mounted and wired manual bypass device.
   1. Manual Bypass
      a. Manual transfer to line power shall be via three (3) contactors sized for applicable voltage and motor current. One (1) contactor shall be between the VFD output and the motor. The second shall be between the bypass power line and the motor, providing across-the-line starting. The third contactor shall be between the line voltage and VFD input. Transferring load via contactors shall disconnect VFD inputs from line voltage and outputs from the motor, thus providing the ability to safely troubleshoot and test the VFD while operating in the bypass mode. A fused disconnect switch shall be required. Bypass and VFD output contactors shall be electrically and mechanically interlocked to prevent both being closed at the same time. Include motor thermal overload protection in bypass and VFD modes.
   2. Provide two (2) 3-position selector switches to control bypass contactor and the VFD input and output contactors: 1) Normal-Off-Test and 2) Drive-Off-Bypass. Selector switches shall have padlockable switch covers.
   3. Door mounted status lights shall include power on, drive, bypass, and safety.
   4. Provide terminal strip for connection of fire, smoke contacts, external start command, and VFD control signal. All external interlocks shall function in hand, auto, or bypass. External start/stop signal shall be functional in auto and bypass modes.
   5. The 120-volt ac control power shall be supplied by the fused transformer.
   6. Provide a NEMA 1 enclosure for bypass components and a NEMA 4 enclosure is required for outdoor applications. Bypass and VFD enclosures shall be factory wired and assembled on a common backplate.
   7. Manual bypass and accessories shall be furnished and mounted by the VFD manufacturer.
   8. Two (2) contactor bypasses and knife switches are not acceptable.
   9. The bypass device shall allow the load to run across-the-line while electrically isolating the VFD so that maintenance can be performed on the drive components.
2.3 CONTROL FEATURES

A. The VFD shall be provided with the following control features:

1. Factory mounted and wired Hand-Off-Auto selector switch that allows local or remote starting or stopping of the drive. Separate start and stop buttons, electronic circuits that “virtually” provide this capability or other alternative devices are not acceptable.

2. Factory mounted and wired VFD-Bypass switch.

3. Factory mounted and wired Local-Remote speed control switch, that allows either local or remote control of the drive speed. Key pad buttons are also acceptable provided that permanently labeled, dedicated buttons are provided for the local and the remote speed control functions.

4. Main input disconnect switch.

5. Inverter input and output disconnect switch, accessible without opening the drive cabinet, if a bypass device is provided.

6. Manual speed potentiometer or keypad control, for local speed control with the Local-Remote speed control switch in the Local position.

7. VFD shall accept an input reference (feedback) signal, 4-20 mA analog input, for remote speed control with the Local-Remote speed control switch in the Remote position. Provide input signal; isolation to isolate input signal ground from the VFD internal ground control. Coordinate required 4-20 mA analog input with DDC control system supplier.

8. A remote start/stop contact input that functions in the automatic mode only.

9. A safety interlock circuit that functions in drive and bypass modes. All safety and limit controls must function in both automatic and manual operating modes.

10. A run permissive circuit, separate from the safety interlock circuit, which prevents motor operation whether in drive or bypass mode. This circuit, via the customer’s external contact device, signals the motor may run, provided the safety interlock contact(s) is made. A typical application would be for a time delay before motor start to allow some external event to occur. The run permissive circuit shall be jumpered from the factory.

11. Provide the following drive initiated external circuits:
   a. Powered run mode: A circuit that is powered after the motor is started in drive or bypass modes.
   b. Powered run request: A circuit that is powered whenever the drive safety interlock contact(s) are closed, and the drive H-O-A is in hand, or the drive H-O-A is in auto and the remote start/stop contact is closed.

12. A standard USB port for direct connection of a Personal Computer (PC) to the VFD. The manufacturer shall provide PC software to allow complete setup and access to the VFD through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the Building Management System (BMS).

13. An integral proportional-integral-derivative (PID) controller that, when activated, controls drive speed to maintain a programmed set point based on a remote analog input feedback signal.
   a. The VFD shall be able to apply a scaling factor to the feedback signal.
   b. The VFD shall be able to calculate the square root of the feedback signal so that a pressure sensor can be used to measure flow.
c. The analog feedback signal must be linear in nature when inputting to the on-board (PID) controller using this feature.

14. A real-time clock shall be an integral part of the VFD.
   a. It shall be possible to use this to display the current date and time on the VFD’s display.
   b. The clock shall include a time clock function with 7-day programmability and a minimum of four (4) programmable time periods per day, with individually selectable ON and OFF functions. The time clock function shall be programmable to control start/stop functions, constant speeds, PID parameter set points and output relays. The time clock function shall be programmable through the controller display and keypad, or by included software that allows programming via a PC and a USB connection.

15. VFD shall be capable of starting a coasting load. Provide a bi-directional auto speed search to allow starting into rotating loads spinning in either direction.

16. VFD shall automatically attempt to restart a minimum of three (3) times during an adjustable time period of no less than 30 seconds after shutting off for any reason, except for a short circuit or motor overload.

17. The VFD shall have adjustable motor acceleration and deceleration rates from 0.1 to 1,800 seconds. Provide maximum Hz speed settings. Provide current limiting feature.

18. The VFD shall have the ability to lock-out a minimum of four (4) critical frequency ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment.

19. The VFD shall be configured as required to meet system operational requirements including:
   a. Provide one (1) normally open and one (1) normally closed auxiliary contacts to actuate when the motor is started in any mode.
   b. Provide an additional set of N.O. contacts on the VFD-bypass switch that close when the switch is set to bypass.
   c. Provide a minimum of one (1) 4-20 mA analog output signal selectable to proportionally indicate drive output frequency, current, or power, or to indicate the VFD input reference/feedback signal, for monitoring by the DDC control system or the Building Management System.
   d. Provide remote communication to the building DDC/BMS control system.
      1) The drive shall be configured to communicate with several different fieldbuses, making it easy to communicate with a variety of control systems. Fieldbus options are as follows: ● BACnet ● N2 / Modbus ● LonWorks
      2) The DDC system shall be capable of receiving all VFD fault and trips, current, voltage, and power consumption through the communication interface. The communication capabilities shall include but not be limited to the following:
         a) Output Frequency / Speed
         b) Motor Current
         c) Output voltage
         d) Motor Power (kW)
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e) Analog Input Valves
f) Drive Status
g) Motor Speed / Torque
h) Run Time
i) Accel / Decel Time Adjustments
j) VFD Fault Status
k) Start / Stop Control (if not required to be hardwired)

2.4 INDICATORS

A. Provide an indicating lamp for “POWER AVAILABLE”. Lights shall be LED type.
B. A motor RPM and AMP display shall be factory mounted on the face of the unit, either as a separate indicator or via the controller display.

2.5 SAFETIES

A. Provide LED type status lights or digital display indication of the cause of any shutdown.
B. The VFD shall be provided with the following safety features:
   1. VFD over voltage and under voltage protection and protection against temporary power outages.
   2. VFD over temperature protection.
   3. Motor over temperature protection per NEC 430.126(A) (2).
   4. Short circuit and ground fault protection.
   5. Separate motor overload protection functional in bypass and normal operation. For VFD’s controlling multiple motors, provide overload protection for each motor.
   6. Integral phase-loss protection
   7. Adjustable current limiter.

2.6 LABELING

A. Provide engraved plastic labels permanently attached to the VFD panel face indicating the function of all switches and indicators, and the equipment served.
B. Tag all wiring in the drive. Tag nomenclature shall match the corresponding wire identification nomenclature indicated on the approved drive submittal.
C. For VFD’s serving smoke purge, stair pressurization, or other smoke control systems, include an engraved permanently attached red faced label, minimum 8” x 8”, with the following nomenclature: “CAUTION: THIS VFD IS PART OF A LIFE SAFETY SMOKE CONTROL SYSTEM. NOTIFY THE OWNER PRIOR TO ANY CHANGE OR MAINTENANCE ACTIVITY TO THIS DRIVE”.

VARIABLE FREQUENCY DRIVES
PART 3 - EXECUTION

3.1 INSTALLATION

A. Unit installation, including mounting, supports, and wiring to motor, shall be by the Electrical Trades, in compliance with Division 26. Coordinate with the Mechanical Trades and the Control Trades, as required.

B. Install the VFD as close as possible to the motor. The load side power cables to the motor shall be kept as short as possible and shall not be run in the same conduit as the line side power cables. Control wiring shall be in separate conduit from power wiring. Where applicable, control wires from the motor disconnect early break contacts may be installed with the motor power wiring.

C. Provide “shaft grounding” since modern AC or DC variable speed motors develop an electrical potential between the shaft and the frame of the motor. It has been found that shaft-to-frame voltages above three (3) volts generally cause current flow across the bearings. When current flows across a bearing, metal is transferred causing frosting, pitting, and fluting of the bearing races resulting in premature failure of the bearings. Grounding the shaft to the frame provides a path for the current to flow around the bearings eliminating the bearing damage caused by shaft potentials. Therefore, all installed VFD’s shall include a shaft grounding brush as manufactured by “Shaft Grounding Systems, Inc.” (SGS) on all fan and pump motors. The products manufactured by SGS contain only stable materials and are not believed to constitute a hazardous material as defined under the Office of Safety and Health Act (OSHA) regulations. Specifically developed proprietary carbon compounds are used by SGS to ensure sustained performance. At present, the brush wear life expectancy is from 3 to 5 years based upon data obtained from running these brushes for over two (2) years in continuous industrial applications. In systems designed for wet or severe environment applications, the brush contact area shall be sealed to keep contaminants from entering the shaft grounding system. The shaft grounding system shall be designed to reduce shaft voltage levels to less than the three (3) volts typically required for current to pass through bearings. Shaft voltages without a shaft grounding system typically range from 3 to 30 volts, or higher.

D. Protect the unit from dirt, dust, water, and physical damage prior to and during construction. If the inside of the unit becomes dirty or dusty before acceptance by the Owner, it shall be thoroughly cleaned by the unit manufacturer at the contractor’s expense.

3.2 QUALITY ASSURANCE

A. Upon completion of manufacturing, each VFD unit shall be inspected and load tested prior to shipment. The Owner’s representative may be present for factory-acceptance tests. Tests to be conducted shall include but are not limited to simulating system logic. All associated costs for said tests shall be included in the manufacturers bid. Certification that the factory inspections and load tests have been successfully performed shall be submitted to the Owner after completion of the tests.
3.3 CHECK, TEST AND START

A. After installation of the system at the site a field acceptance test shall be performed by the Mechanical trades in conjunction with the manufacturer of the drive equipment, who will provide the services of a factory trained and certified technician to supervise the check, test and start.

B. The mechanical contractor shall notify the Owner's representative five (5) days prior to the start-up procedure.

C. The field acceptance test shall consist of a repeat of the factory test. Functional tests shall demonstrate satisfactory operation of all interlocks, alarms, and normal operational sequences. The drive manufacturer shall use suitable test equipment to locate and correct all malfunctions. Repeated failure of any component will cause the test to be terminated and restarted when the equipment has been fixed. Harmonic distortion tests shall be run on the drives and the bus to determine the voltage and current distortion. IEEE 519-1992 standards shall be used as the guide to test results. Measurements shall be made utilizing a Dranetz analyzer or a BMI analyzer capable of indicating snapshots of the current and voltage distortions. Measurements shall include phase to phase, phase to neutral, and neutral to ground. The test shall be run the full range of the drive operation. The graphs of the test results shall be submitted for speed values of 60%, 80%, and 100%. Also, test shall be done with no units running, then one unit, then two units, etc. Tests shall be conducted by a qualified technician acceptable to the Owner. Included in the scope of this specification shall be an allowance for a factory-trained service engineer, other than sales representatives, to inspect, perform final adjustments and operational checks, perform functional checks, and prepare a final report for record purposes. A minimum of one day shall be allowed for this start-up service.

D. The “Capacity Test” to insure that energy use is minimized, the HVAC system must be balanced at design conditions at the lowest possible static pressure (SP). This requires that the lowest possible SP be found at the sensor that will allow full design flow at the Terminal Air Unit (TAU) most difficult to satisfy. This system minimum SP found is what the VFD should control to. To accomplish this verify that the TAU on the critical leg has its damper 90% or more open when all TAU’s taking off upstream of the static pressure sensor are in full cooling. The “Capacity Test” to minimize energy usage in the hydronic system, it must be balanced at design conditions at the lowest differential pressure (DP) possible. This requires that the lowest possible DP at the sensor be found that will allow the delivery of design flow through the valve most difficult to satisfy. This system minimum DP found is what the VFD should control to. This is accomplished by changing the temperature setpoint for all zones to 55ºF for cooling or 85ºF for heating coils, causing all AHU coil valves to be calling for full cooling or heating, as applicable. Each coil's flow is then measured against the design flow. The coil that is receiving the lowest the lowest fraction of design is identified. The current DP at the controlling sensor is noted. A calculation is made, giving the DP required at the sensor to allow the identified most critical coil to meet its design flow.

E. The Mechanical trades shall submit a “Certificate of Proper Installation” to the Owner confirming that all equipment was inspected, operation checked, and installation approved in writing by the manufacturer’s representative.

F. UNDER NO CIRCUMSTANCES ARE ANY PORTIONS OF THE VARIABLE FREQUENCY DRIVE SYSTEM TO BE ENERGIZED WITHOUT AUTHORIZATION FROM THE MANUFACTURER’S REPRESENTATIVE.
3.4 TRAINING

A. Conduct a minimum of four (4) hours training for maintenance staff on operation, programming, and service of VFD’s. Training shall be conducted by a factory trained service technician.

B. Training shall not be performed until system is operational and functional and two (2) weeks after receiving approved job specific technical manuals.

END OF SECTION 20 05 14
SECTION 20 05 16 - EXPANSION FITTINGS AND LOOPS FOR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Flexible-hose packless expansion joints.
   2. Metal-bellows packless expansion joints.
   3. Pipe loops and swing connections.
   4. Expansion-compensator packless expansion joints.
   5. Alignment guides and anchors.

B. Related Sections include the following:
   1. Division 20 Section 20 05 29 Section "Hangers and Supports" for hangers and supports.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.
1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flex Pression Ltd.
      b. Flex-Hose Co.
      c. Flexicraft Industries.
d. Mason Industries.

e. Metraflex Company.

f. Unisource Manufacturing.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.


a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

B. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex Pression Ltd.

b. Flex-Hose Co.

c. Flexicraft Industries.

d. Flo Fab.

e. Mason Industries.

f. Metraflex Company.

g. Unaflex.


3. Type: Circular, corrugated bellows with external tie rods.

5. Configuration: Single- or double-joint with base class(es) unless otherwise indicated.

   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded

   a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged or welded

C. Metal, Expansion-Compensator Packless Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flex Pression Ltd.
      b. Flexicraft Industries.
      c. Mason Industries.
      d. Metraflex Company.
      e. Unaflex.

   2. Minimum Pressure Rating: 200 psig unless otherwise indicated.

   3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
      a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded
      b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.

   4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
      a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
      b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or welded

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flex-Hose Co.
      b. Flex-Weld.
      c. Flexicraft Industries.
      d. Mason Industries.
      e. Metraflex Company.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
   5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
      b. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install packed-type expansion joints with packing suitable for fluid service.

C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

H. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 20 05 16
SECTION 20 05 19 - METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Bimetallic-actuated thermometers.
   2. Liquid-in-glass thermometers.
   3. Thermowells.
   4. Dial-type pressure gages.
   5. Gage attachments.
   6. Test plugs.
   7. Sight flow indicators.
   8. Orifice flowmeters.
  10. Turbine flowmeters.

B. Related Sections:
   1. Division 22 Section “Domestic Water Piping” for water meters inside the building.
   2. Division 23 Section “Facility Natural-Gas Piping” for gas meters.
   3. Division 23 Section “Steam and Condensate Heating Piping” for steam and condensate meters.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers, gages, and flowmeters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer, gage, and flowmeter, signed by product manufacturer.

D. Operation and Maintenance Data: For flowmeters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft.
   3. Trice.
   5. Weiss Instruments.


C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F

E. Connector Type(s): Union joint, adjustable angle rigid, bottom, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass or plastic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.
K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flo Fab.
   b. Miljoco Corporation.
   c. Trerice.
   d. Weiss Instruments.


3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and blue or red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F

7. Window: Glass or plastic.

8. Stem: Aluminum and of length to suit installation.
   b. Design for Thermowell Installation: Bare stem.


10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:


2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: CNR or CUNI.

4. Material for Use with Steel Piping: CRES.

5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell’s internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Manufacturers: Same as manufacturer of thermometer being used.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK.
      b. Ashcroft.
      c. Miljoco Corporation.
      d. Trerice.
      e. Watts.
      f. Weiss Instruments.
   3. Case: Indicating type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
   9. Window: Glass or plastic.
  10. Ring: Metal
  11. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
  12. Range for Fluids under Pressure: Two times operating pressure.
  13. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and porous-metal -type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design.
   2. Peterson Equipment Co.
   4. Trerice.
   5. Watts.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Corrosion-resistant brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
   2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

2.8 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dwyer Instruments.
   2. Emerson Process Management.
   3. Ernst Co.
   4. Ernst Flow Industries.
   5. Penberthy.
2.9 FLOWMETERS

A. Orifice Flowmeters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB
      b. Bell & Gossett
      d. Preso Meters.
      e. S. A. Armstrong Limited.
   2. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
   3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
      a. Design: Differential-pressure-type measurement for steam and water.
      b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
      c. Minimum Pressure Rating: 300 psig.
      d. Minimum Temperature Rating: 250 deg F.
   5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
      a. Scale: Gallons per minute.
      b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
   6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.
      a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

7. Display: Visual instantaneous rate of flow


9. Operating Instructions: Include complete instructions with each flowmeter.

B. Pitot-Tube Flowmeters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB.
   b. Emerson Process Management
   d. Preso Meters.
   e. Taco.
   f. Veris Industries.

2. Description: Flowmeter with sensor and indicator.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
   a. Design: Differential-pressure-type measurement for water.
   b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
   c. Minimum Pressure Rating: 150 psig (1035 kPa).
   d. Minimum Temperature Rating: 250 deg F (121 deg C).
   e. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.

5. Integral Transformer: For low-voltage power connection.

6. Accuracy: Plus or minus 3 percent.

7. Display: Visual instantaneous rate of flow

8. Operating Instructions: Include complete instructions with each flowmeter.

C. Turbine Flowmeters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB.
   b. Data Industrial Corp.
   c. EMCO Flow Systems.
   d. ERDCO Engineering Corp.
   e. Hoffer Flow Controls.
   f. Liquid Controls.
g. McCrometer.
h. Midwest Instruments & Controls Corp.
i. ONICON Incorporated.
j. SeaMetrics.
k. Sponsler.

2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
   a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for steam or water.
   b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
   d. Minimum Temperature Rating: 180 deg F.
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Accuracy: Plus or minus 1-1/2 percent.
7. Display: Visual instantaneous rate of flow
8. Operating Instructions: Include complete instructions with each flowmeter.

D. Venturi Flowmeters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB.
      b. Gerand Engineering Co.
      c. Hyspan Precision Products.
      d. Preso Meters; a division of Racine Federated.
      e. S. A. Armstrong Limited.
      f. Victaulic Company.
   2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
   3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
      a. Design: Differential-pressure-type measurement for steam or water.
      b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
      d. Minimum Temperature Rating: 250 deg F.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.
L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install wafer-orifice flowmeter elements between pipe flanges.

Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

R. Install permanent indicators on walls or brackets in accessible and readable positions.

S. Install connection fittings in accessible locations for attachment to portable indicators.

T. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

U. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.

V. Install thermometers in the following locations:
   1. Plumbing Systems:
      a. Inlet and outlet of each water heater.
      b. 
      c. Inlet and outlet of each domestic hot-water storage tank.
      d. Two inlets of each mixing valve.
   2. HVAC Systems:
      a. Inlet and outlet of each hydronic zone.
      b. Inlet and outlet of each hydronic boiler.
      c. Outside-, return-, supply-, and mixed-air ducts.

W. Install pressure gages in the following locations:
   1. Plumbing Systems:
      a. Building water service entrance into building.
      b. Inlet and outlet of each pressure-reducing valve.
      c. Suction and discharge of each domestic water pump.
   2. HVAC Systems:
      a. Inlet and outlet of each pressure-reducing valve.
      b. Suction and discharge of each pump.
3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer’s written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
   1. Industrial -style, liquid-in-glass type.
   2. Test plug with EDPM self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic zone shall be the following:
   1. Industrial -style, liquid-in-glass type.
   2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
   1. Industrial -style, liquid-in-glass type.
   2. Test plug with EPDM self-sealing rubber inserts.
   3. inserts.

D. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
   1. Industrial -style, liquid-in-glass type.
   2. Liquid-filled, bimetallic-actuated type.
   3. Test plug with -sealing rubber inserts.

E. Install liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.

F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F
B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

C. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F

D. Scale Range for Steam and Steam-Condensate Piping: 30 to 240 deg F.

E. Scale Range for Air Ducts: 0 to 150 deg F

### 3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:
   1. Liquid-filled direct-mounted, metal case.
   2. Test plug with EDPM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:
   1. Liquid-filled direct-mounted, metal case.
   2. Test plug with EDPM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be the following:
   1. Liquid-filled direct-mounted, metal case.
   2. Test plug with EDPM self-sealing rubber inserts.

D. Pressure gages at discharge of each hydronic pressure-reducing valve shall be the following:
   1. Liquid-filled direct-mounted, metal case.
   2. Test plug with EDPM self-sealing rubber inserts.

E. Pressure gages at suction and discharge of each HVAC pump shall be the following:
   1. Liquid-filled direct mounted, metal case.
   2. Test plug with EDPM self-sealing rubber inserts.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi

B. Scale Range for Domestic Water Piping: 0 to 100 psi

C. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi

D. Scale Range for Steam Piping (steam less than 15 psig): 0 to 30 psi
3.8 FLOWMETER SCHEDULE

A. Flowmeters for Heating, Hot-Water Piping: Orifice, Pitot-tube, or Turbine type.

B. Flowmeters for Steam and Steam-Condensate Piping: Venturi type.

END OF SECTION 20 05 19
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SECTION 20 05 23 - GENERAL-DUTY VALVES FOR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Bronze angle valves.
   2. Bronze ball valves.
   4. Bronze lift check valves.
   5. Bronze swing check valves.
   7. Iron swing check valves with closure control.
  11. Iron gate valves.
  15. Chainwheels.

B. Related Sections:
   1. Division 20 Section 20 05 53 “Mechanical Identification” for valve tags and schedules.
   2. Division 22 Section 22 05 23 “Valves for Plumbing Piping” for valves applicable only to this piping.
3. Division 22 Section 22-11-16 "Domestic Water Piping" for valves applicable only to this piping.

1.3 DEFINITIONS

A. ASME: American Society of Mechanical Engineers.
D. CWP: Cold working pressure.
E. EPDM: Ethylene propylene copolymer rubber.
F. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
G. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
H. NRS: Nonrising stem.
I. OS&Y: Outside screw and yoke.
J. PTFE: Polytetrafluoroethylene plastic.
K. RS: Rising stem.
L. SWP: Steam working pressure.
M. TFE: Tetrafluorethylene plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
   a. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
3. Threaded: With threads according to ASME B1.20.1.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Class 150, Bronze Angle Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Valve Group; Crane Valves.
   b. Crane Valve Group; Jenkins Valves.
   c. Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. Nibco.
   g. Powell Valves.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron

K. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Lance Valves.
e. Milwaukee Valve Company.
f. Nibco.
g. Watts.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

L. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls; a division of ABZ Manufacturing.
      b. Conbraco Industries; Apollo Valves.
      c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
      d. Crane Valve Group; Jenkins Valves.
      e. Crane Valve Group; Stockham Division.
      f. DeZurik Water Controls.
      g. Flo Fab.
      h. Hammond Valve.
      i. Kitz Corporation.
      j. Legend Valve.
      k. Milwaukee Valve Company.
      l. Nibco.
      m. Norriseal; a Dover Corporation company.
      n. Red-White Valve Corporation.
      o. Spence Strainers International; a division of CIRCOR International.
      p. Watts Regulator Co.; a division of Watts Water Technologies.
   2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.2 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flo Fab Inc.
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. Mueller Steam Specialty; a division of SPX Corporation.
   f. NIBCO INC.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded.
   f. Disc: NBR, PTFE, or TFE.

2.3 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.4 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Valve Group; Crane Valves.
   b. Crane Valve Group; Jenkins Valves.
   c. Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Legend Valve.
   g. Milwaukee Valve Company.
   h. Nibco.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Sure Flow Equipment.
   l. Watts Regulator Co.; a division of Watts Water Technologies.
   m. Zy-Tech Global Industries.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
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**2.5 IRON SWING CHECK VALVES WITH CLOSURE CONTROL**

**A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NIBCO INC.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and spring.
B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves. Crane Co.; Crane Valve Group; Jenkins Valves.
      b. Crane Co.; Crane Valve Group; Stockham Division.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.
      h. Closure Control: Factory-installed, exterior lever and weight.

2.6 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. APCO Willamette Valve and Primer Corporation.
      c. Crispin Valve.
      d. DFT Inc.
      e. Flo Fab Inc.
      f. GA Industries, Inc.
      g. Hammond Valve.
      h. Metraflex, Inc.
      i. Milwaukee Valve Company.
      j. Mueller Steam Specialty; a division of SPX Corporation.
      k. NIBCO INC.
      l. Spence Strainers International; a division of CIRCOR International.
m. Sure Flow Equipment Inc.

n. Val-Matic Valve & Manufacturing Corp.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   d. Style: Compact wafer.
   e. Seat: Bronze.

B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flomatic Corporation.
      e. Hammond Valve.
      f. Metraflex, Inc.
      g. Milwaukee Valve Company.
      h. Mueller Steam Specialty; a division of SPX Corporation.
      i. NIBCO INC.
      j. Spence Strainers International; a division of CIRCOR International.
      k. Sure Flow Equipment Inc.
      l. Val-Matic Valve & Manufacturing Corp.
      m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: Bronze.

C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
c. Val-Matic Valve & Manufacturing Corp.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
   d. Style: Compact wafer.
   e. Seat: Bronze.

D. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: Bronze.

E. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Metraflex, Inc.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Sure Flow Equipment Inc.
      j. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
d. Style: Compact wafer, spring loaded.
e. Seat: Bronze.

F. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flomatic Corporation.
      e. Hammond Valve.
      f. Metraflex, Inc.
      g. Milwaukee Valve Company.
      h. Mueller Steam Specialty; a division of SPX Corporation.
      i. NIBCO INC.
      j. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: Bronze.

G. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      d. Style: Compact wafer, spring loaded.
      e. Seat: Bronze.
H. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: Bronze.

I. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Spence Strainers International; a division of CIRCOR International.
      i. Sure Flow Equipment Inc.
      j. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 and larger, CWP Rating: 200 psig.
      d. Style: Compact wafer.
      e. Seat: EPDM or NBR.

J. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
b. APCO Willamette Valve and Primer Corporation.
c. Crispin Valve.
d. DFT Inc.
e. GA Industries, Inc.
f. Hammond Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Sure Flow Equipment Inc.
j. Val-Matic Valve & Manufacturing Corp.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   d. Style: Globe, spring loaded.
   e. Ends: Flanged.
   f. Seat: EPDM or NBR.

K. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      e. Style: Compact wafer.
      f. Seat: EPDM or NBR.

L. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Val-Matic Valve & Manufacturing Corp.
2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
   d. Style: Globe, spring loaded.
   e. Ends: Flanged.
   f. Seat: EPDM or NBR.

M. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Sure Flow Equipment Inc.
      i. Val-Matic Valve & Manufacturing Corp.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
   d. Style: Compact wafer, spring loaded.
   e. Seat: EPDM or NBR.

N. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Val-Matic Valve & Manufacturing Corp.

2. Description:
O. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      d. Style: Compact wafer, spring loaded.
      e. Seat: EPDM or NBR.

P. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: EPDM or NBR.

2.7 IRON, PLATE-TYPE CHECK VALVES

A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. APCO Willamette Valve and Primer Corporation.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Flomatic Corporation.
   d. Mueller Steam Specialty; a division of SPX Corporation.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Seat: Bronze.

B. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      e. Seat: Bronze.

C. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crane Co.; Crane Valve Group; Crane Valves.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      d. Body Material: ASTM A 126, gray iron.
      e. Seat: Bronze.
D. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. Val-Matic Valve & Manufacturing Corp.

   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      e. Seat: Bronze.

E. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Inc.
      b. Sure Flow Equipment Inc.

   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      d. Body Material: ASTM A 126, gray iron.
      e. Seat: EPDM or NBR.

F. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Cooper Cameron Valves TVB Techno.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Crane Co.; Crane Valve Group; Stockham Division.
      e. NIBCO INC.
      f. Spence Strainers International; a division of CIRCOR International.
      g. Sure Flow Equipment Inc.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
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b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c.
e. Body Material: ASTM A 126, gray iron.
f. Seat: EPDM or NBR.

G. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      e. Seat: EPDM or NBR.

H. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sure Flow Equipment Inc.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      d. Body Material: ASTM A 126, gray iron.
      e. Seat: EPDM or NBR.

I. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Sure Flow Equipment Inc.
   2. Description:
b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
c. 
e. Body Material: ASTM A 126, gray iron.
f. Seat: EPDM or NBR.

3. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Val-Matic Valve & Manufacturing Corp.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve.
      b. Crane Valve Group; Crane Valves.
      c. Crane Valve Group; Jenkins Valves.
      d. Crane Valve Group; Stockham Division.
      e. Hammond Valve.
      f. Kitz Corporation.
      g. Milwaukee Valve Company.
      h. Nibco.
      i. Powell Valves.
      j. Red-White Valve Corporation.
      k. Watts Regulator Co.; a division of Watts Water Technologies.
      l. Zy-Tech Global Industries.

   2. Description:
      a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron

B. Class 125, RS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Crane Co.; Crane Valve Group; Stockham Division.
      e. Hammond Valve.
      f. Kitz Corporation.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Powell Valves.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      k. Zy-Tech Global Industries, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 200 psig.
      d. Ends: Threaded [or solder joint].
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron

C. Class 150, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Kitz Corporation.
      c. Milwaukee Valve Company.
d. NIBCO INC.
e. Powell Valves.
f. Red-White Valve Corporation.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron

D. Class 150, RS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Stockham Division.
      c. Hammond Valve.
      d. Kitz Corporation.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Powell Valves.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      i. Zy-Tech Global Industries, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 300 psig.
      d. Ends: Threaded.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron
2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Kitz Corporation.
      g. Legend Valve.
      h. Milwaukee Valve Company.
      i. NIBCO INC.
      j. Powell Valves.
      k. Red-White Valve Corporation.
      l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      m. Zy-Tech Global Industries, Inc.

   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Kitz Corporation.
      g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

C. Class 250, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. NIBCO INC.

2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

D. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Milwaukee Valve Company.
2. **Description:**
   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Disc: Solid wedge.
   h. Packing and Gasket: Asbestos free.
   
**E. Class 150, Bronze Globe Valves with Nonmetallic Disc:**

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Crane Valve Group; Crane Valves.
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. Nibco.
   f. Powell Valves.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies.
   i. Zy-Tech Global Industries.

2. **Description:**
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.
2.10 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Powell Valves.
      i. Red-White Valve Corporation.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      k. Zy-Tech Global Industries, Inc.

   2. Description:
      a. Standard: MSS SP-85, Type I.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM A 126, gray iron with bolted bonnet.
      d. Ends: Flanged.
      e. Trim: Bronze.
      f. Packing and Gasket: Asbestos free.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   1. Bronze ball valve as specified in this Section.
   2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries.
   3. Trumbull Industries.
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to butterfly, gate, globe valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly, gate, and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.
3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
3. Throttling Service except Steam: Globe or butterfly valves.
4. Throttling Service, Steam: Globe or butterfly valves.
5. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronzedisc.
   b. NPS 2-1/2 and Larger for Hydronic: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal seat check valves.

B. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
5. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronzedisc.
3. Ball Valves: Two Three piece, full regular port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125, bronze nonmetallic disc.
5. Bronze Gate Valves: Class 125NRS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
6. Iron, Center-Guided Check Valves: [Class 125] [Class 150] [Class 250] [Class 300], [compact-wafer] [globe], [metal] [resilient] seat.
7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.
8. Iron Gate Valves: Class 250, [NRS] [OS&Y].

3.6 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
1. Bronze Angle Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
2. Ball Valves: [One] [Two] [Three] piece, [full] [regular] [reduced] port, [brass] [or] [bronze] with [brass] [bronze] [stainless-steel] trim.
3. Bronze Swing Check Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
4. Bronze Gate Valves: [Class 125] [Class 150], [NRS] [RS].
5. Bronze Globe Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.

B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. High-Performance Butterfly Valves: [Class 150] [Class 300], single flange.
4. Iron Swing Check Valves: [Class 125] [Class 250], [metal] [nonmetallic-to-metal] seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and [spring] [weight].
6. Iron Gate Valves: [Class 125] [Class 250], [NRS] [OS&Y].
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: [Class 125] [Class 250].

3.7 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:
1. Bronze Angle Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
2. Ball Valves: [One] [Two] [Three] piece, [full] [regular] [reduced] port, [brass] [or] [bronze] with [brass] [bronze] [stainless-steel] trim.
3. Bronze Swing Check Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
4. Bronze Gate Valves: [Class 125] [Class 150], [NRS] [RS], bronze.
5. Globe Valves: Class [125] [150], bronze, [bronze] [nonmetallic] disc.

B. Pipe Sizes NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Ball Valves, NPS 2-1/2 to NPS 10: Class 150, iron.
3. High-Performance Butterfly Valves: [Class 150] [Class 300], single flange.
4. Iron Swing Check Valves: [Class 125] [Class 250], [metal] [nonmetallic-to-metal] seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and [spring] [weight].
6. Iron Gate Valves: [Class 125] [Class 250], [NRS] [OS&Y].
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: [Class 125] [Class 250].

3.8 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze Angle Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
2. Ball Valves: [One] [Two] [Three] piece, [full] [regular] [reduced] port, [brass] [or] [bronze] with [brass] [bronze] [stainless-steel] trim.
3. Bronze Swing Check Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.
4. Bronze Gate Valves: [Class 125] [Class 150], [NRS] [RS].
5. Bronze Globe Valves: [Class 125] [Class 150], [bronze] [nonmetallic] disc.

B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. High-Performance Butterfly Valves: [Class 150] [Class 300], single flange.
4. Iron Swing Check Valves: [Class 125] [Class 250], [metal] [nonmetallic-to-metal] seats.
5. Iron Swing Check Valves with Closure Control: Class 125, lever and [spring] [weight].
6. Iron Gate Valves: [Class 125] [Class 250], [NRS] [OS&Y].
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: [Class 125] [Class 250].
SECTION 20 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following hangers and supports for fire protection system, plumbing system, and HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Non-metallic pipe hangers and supports.
   4. Metal framing systems.
   5. Non-metallic strut systems
   6. Fastener systems.
   7. Pipe stands.
   8. Pipe positioning systems.
   9. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section 05 00 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 20 Section 20 05 16 "Expansion Fittings and Loops for Piping" for pipe expansion joints, pipe expansion loops, pipe guides and pipe anchors.
   3. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. ASCE: American Society of Civil Engineers.
B. ASME: American Society of Mechanical Engineers.
E. IAPMO: International Association of Plumbing and Mechanical Officials.
F. MFMA: Metal Framing Manufacturers Association.
G. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
H. SSPC: Steel Structures Painting Council now the Society for Protective Coatings.
I. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS
A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Non-metallic pipe hangers and supports.
   3. Thermal-hanger shield inserts.
B. Shop Drawings: Show fabrication and installation details and include calculations stamped by a structural engineer licensed to perform work in the State of Michigan for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   4. Pipe stands. Include Product Data for components.
   5. Equipment supports.
C. Welding certificates.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code--Sheet Steel."
B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 “Hanger and Support Applications” Article for where to use specific hanger and support types.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAA Technology & Specialties Co., Inc.
   5. Carpenter & Paterson, Inc.
   6. Empire Industries, Inc.
   7. ERICO/Michigan Hanger Co.
   8. Globe Pipe Hanger Products, Inc.
   9. Grinnell Corp.
   10. GS Metals Corp.
   12. PHD Manufacturing, Inc.
   13. PHS Industries, Inc.
   15. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Non-metallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 NON-METALLIC PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of stainless steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International.
      b. B-Line Systems, Inc.; a division of Cooper Industries.
      c. Champion Fiberglass, Inc.
      d. Cope, T. J., Inc.; Tyco International, Ltd.
      e. Seasafe, Inc.
      f. Unistrut Corp.; Tyco International, Ltd.
      g. Wesanco, Inc.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Plasti-Fab, Inc.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel or stainless steel channels and other components with appropriate finish based on location of use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anvil International.
   2. B-Line Systems, Inc.; a division of Cooper Industries.
   3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   4. GS Metals Corp.
   7. Tolco Inc.
   8. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer’s standard finish, unless bare metal or galvanized surfaces are indicated.
D. Non-metallic Coatings: Plastic coating, jacket, or liner.

2.6 NON-METALLIC STRUT SYSTEMS
A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anvil International.
   2. B-Line Systems, Inc.; a division of Cooper Industries.
   3. Champion Fiberglass, Inc.
   4. Cope, T. J., Inc.; Tyco International Ltd.
   5. Seasafe, Inc.

2.7 THERMAL-HANGER SHIELD INSERTS
A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.
C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate
E. Insulation-Insert Material for Closed Cell Foam Insulated Piping: As manufactured by Klo-Sure or approved equal.
F. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
G. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
H. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
I. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.8 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping, ductwork and equipment.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Portable Pipe Hangers.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Portable Pipe Hangers.


3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Portable Pipe Hangers.
   2. Bases: One or more plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from hot dip galvanized components including structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.
   4. Sioux Chief Manufacturing Co.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel or stainless steel shapes with appropriate finish based on location of use.

2.11 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Stainless Steel: ASTM A 304, stainless steel plates, shapes, and bars.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and non-metallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use non-metallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts, or equipment.

G. Hangers and supports shall also be provided at every change in direction and within 12 inches of any pipe fitting and valves.

H. Pipe hangers in fan rooms and in mechanical equipment rooms shall be provided with spring hangers with elastomeric inserts to eliminate noise transmission between piping and the building structure. Refer to Division 20 “Vibration and Seismic Controls.”

I. Hanger components shall not be used for purposes other than for which they were designed.

J. Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.

K. Where negligible movement of pipe occurs at hanger locations, rod hangers may be used for suspended lines. For piping supported from below, braces, brackets or structural cross members may be used.

L. If the vertical angle of the hanger is greater than 4 degrees, a traveling device shall be provided for horizontal movement. For piping supported from below, rollers or roll carriages shall be used.

M. Where significant vertical movement of the pipe occurs at the hanger location, a resilient support shall be used. Spring cushion hangers may be used where vertical movement does not exceed 1/4 inches.

N. Pipe attachments for insulated pipe shall be outside the insulation. Insulation protection shields or high density insulation inserts shall be provided to protect the insulation.

O. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. **Yoke-Type Pipe Clamps (MSS Type 2):** For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. **Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3):** For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. **Steel Pipe Clamps (MSS Type 4):** For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. **Pipe Hangers (MSS Type 5):** For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. **Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6):** For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. **Adjustable, Steel Band Hangers (MSS Type 7):** For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. **Adjustable Band Hangers (MSS Type 9):** For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. **Adjustable, Swivel-Ring Band Hangers (MSS Type 10):** For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. **Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11):** For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. **Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12):** For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. **U-Bolts (MSS Type 24):** For support of heavy pipes, NPS 1/2 to NPS 30.

13. **Clips (MSS Type 26):** For support of insulated pipes not subject to expansion or contraction.

14. **Pipe Saddle Supports (MSS Type 36):** For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. **Pipe Stanchion Saddles (MSS Type 37):** For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. **Adjustable, Pipe Saddle Supports (MSS Type 38):** For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. **Single Pipe Rolls (MSS Type 41):** For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. **Adjustable Roller Hangers (MSS Type 43):** For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. **Complete Pipe Rolls (MSS Type 44):** For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. **Pipe Roll and Plate Units (MSS Type 45):** For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. **Adjustable Pipe Roll and Base Units (MSS Type 46):** For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
P. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

Q. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

R. Building Attachments: Use of “C” clamps and beam clamps of “C” pattern and any modification thereof for pipe sizes 2-1/2 inches and larger is prohibited unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  10. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
       a. Light (MSS Type 31): 750 lb..
       b. Medium (MSS Type 32): 1500 lb..
       c. Heavy (MSS Type 33): 3000 lb..
  11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. **Horizontal Travelers (MSS Type 58):** For supporting piping systems subject to linear horizontal movement where headroom is limited.

S. **Saddles and Shields:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. **Protection Shields (MSS Type 40):** Of length recommended in writing by manufacturer to prevent crushing insulation.
   2. **Thermal-Hanger Shield Inserts:** For supporting insulated pipe.

T. **Spring Hangers and Supports:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. **Restraint-Control Devices (MSS Type 47):** Where indicated to control piping movement.
   2. **Spring Cushions (MSS Type 48):** For light loads if vertical movement does not exceed 1-1/4 inches.
   3. **Spring-Cushion Roll Hangers (MSS Type 49):** For equipping Type 41 roll hanger with springs.
   4. **Spring Sway Braces (MSS Type 50):** To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. **Variable-Spring Hangers (MSS Type 51):** Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
   6. **Variable-Spring Base Supports (MSS Type 52):** Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
   7. **Variable-Spring Trapeze Hangers (MSS Type 53):** Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
   8. **Constant Supports:** For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. **Horizontal (MSS Type 54):** Mounted horizontally.
      b. **Vertical (MSS Type 55):** Mounted vertically.
      c. **Trapeze (MSS Type 56):** Two vertical-type supports and one trapeze member.

U. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

V. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

W. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

X. Use pipe positioning systems (Sioux Chief or approved equal) in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.
3.2 HANGER AND SUPPORT INSTALLATION

A. Provide necessary piping and equipment supporting elements including building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, or other pipes, ducts, or equipment.

B. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Non-metallic Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

F. Non-metallic Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

G. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

H. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

I. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane. Bases shall have sufficient footprint direct contact area to limit loading on roof membrane to be within roofing manufacturer's limitations so as to not void the roofing warranty.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
J. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

K. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


M. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

N. Install lateral bracing with pipe hangers and supports to prevent swaying.

O. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

P. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

Q. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

R. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 SUPPLEMENTARY STEEL

A. Where it is necessary to frame structural members between existing structural steel members or where structural steel members are used in lieu of commercially rated supports, install such supplementary steel in accordance with American Institute of Steel Construction Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Connection to the existing steel shall be with clamps unless otherwise approved by the Engineer.

3.4 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.7 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 20 05 29
SECTION 20 05 33 - HEAT TRACING

GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes heat tracing with the following electric heating cables:
   1. Self-regulating, parallel resistance.

B. Related Sections include the following:
   1. Division 20 Section 20 05 53 Section "Identification for Piping and Equipment."
   2. Division 20 Section 20 07 00 Section "Mechanical Insulation".
   3. Division 26 Section 26 05 26 Section "Grounding and Bonding for Electrical Systems."
   4. Division 26 Section 26 05 19 Section "Low-Voltage Electrical Power Conductors and Cables."

1.3 DEFINITIONS

A. IEEE: Institute of Electrical and Electronics Engineers.


C. NPS: Nominal Pipe Size.

D. OD: Outside Diameter.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chromalox.
   2. Delta-Therm Corporation.
   3. Pyrotenax; a brand of Tyco Thermal Controls LLC.
   4. Raychem; a brand of Tyco Thermal Controls LLC.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated stranded copper bus wires embedded in cross-linked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.
E. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:
   1. Maximum Heat Output: 5 W/ft
   2. Piping Diameter: Refer to drawings.
   3. Number of Parallel Cables: As required for application.
   4. Volts: Coordinate with available dedicated circuit and electrical contractor.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F
   2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
   3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 20 Section 20 05 53 "Mechanical Identification."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:
   1. Install electric heating cables after piping has been tested and before insulation is installed.
   2. Install electric heating cables according to IEEE 515.1.
   3. Install insulation over piping with electric cables according to Division 20 Section 20 07 19 "Mechanical Insulation."
   4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Protect installed heating cables, including non-heating leads, from damage.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
3.5 FIELD QUALITY CONTROL

A. Testing Agency: [Engage a qualified testing agency to perform tests and inspections.]

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing.
   3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 20 05 33
SECTION 20 05 53 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Stencils.
   6. Valve tags.
   7. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.
1.4  COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Brady Co.
   2. Bramer.
   3. Craftmark.
   4. Emed.
   5. Marking Services, Inc.
   6. Seton Name Plate Corp.

2.2  EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel self-tapping screws
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.


6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black

C. Background Color: Yellow

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black, unless specified otherwise in application schedule

C. Background Color: White, unless specified otherwise in application schedule

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum

2. Fasteners: Brass grommet and wire

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
B. Pipe Label Color Schedule:
   1. Domestic Water Piping:
      a. Background Color: Blue.
   2. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Green.
   3. Natural Gas Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
4. **Heating Water Piping:**
   a. Background Color: Red.

5. **Refrigerant Piping:**
   a. Background Color: Red.

6. **Steam Piping:**
   a. Background Color: Red.

7. **Steam Condensate Piping:**
   a. Background Color: Red.

### 3.4 DUCT LABEL INSTALLATION

**A.** Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

**B.** Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer’s option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

**C.** Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

**A.** Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

**B.** Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. **Valve-Tag Size and Shape:**
   a. Cold Water: 1-1/2 inches round
c. Natural Gas: 1-1/2 inches, round.
e. Hot Water: 1-1/2 inches, round.
f. Steam: 1-1/2 inches, round.
g. Steam Condensate: 1-1/2 inches, round.

2. Valve-Tag Color:
   b. Hot Water: Natural.
   c. Natural Gas: Natural.
   d. Refrigerant: Natural.
   e. Heating Water: Natural.
   f. Steam: Natural.
   g. Steam Condensate: Natural.

3. Letter Color:
   b. Hot Water: Black.
   c. Natural Gas: Black.
   d. Refrigerant: Black.
   e. Heating Water: Black.
   f. Steam: Black.
   g. Steam Condensate: Black.

3.6 WARNING-TAG INSTALLATION
   A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 20 05 53
SECTION 20 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Hydronic Piping Systems:
   a. Constant-flow systems.
   b. Variable-flow systems.
   c. Primary-secondary systems.

3. Steam systems.

4. Domestic hot water recirculation systems.

5. Existing systems TAB.

6. Verifying that automatic control devices are functioning properly.

7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

L. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

M. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

N. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

O. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

P. TAB: Testing, adjusting, and balancing.

Q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

R. Test: A procedure to determine quantitative performance of systems or equipment.

S. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.
1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, electronically submit TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

C. Certified TAB Reports: Electronically submit reports prepared, as specified in this Section, on approved forms certified by TAB firm.

D. Sample Report Forms: Submit two sets of sample TAB report forms.

E. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

B. Acceptable TAB Firms: Subject to compliance with requirements, select from one of the following TAB firms:
   1. Absolut Balance Co.
   3. Barmatic Inspecting Co.
   4. Ener-Tech.
   5. EnviroAire – Total Balance, Inc.
   6. International Test & Balance, Inc

C. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: Include at least the following:
      a. Submittal distribution requirements.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.
D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


F. Instrumentation Type, Quantity, and Accuracy: As described in [AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems"] [NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification]."

G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

I. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION
A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY
A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that
AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of systems and equipment.

C. Examine design data, including system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about system and equipment controls.

D. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

F. Examine system and equipment test reports.

G. Examine system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
I. Examine equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine strainers for clean screens and proper perforations.

M. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Equipment and duct access doors are securely closed.
   4. Balance, smoke, and fire dampers are open.
   5. Isolating and balancing valves are open and control valves are operational.
   6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111, SMACNA’s TABB “HVAC Systems - Testing, Adjusting, and Balancing” and this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling unit components.

J. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer’s written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each 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.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.

6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

B. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

3. Set terminal units at full-airflow condition.

4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

5. Adjust terminal units for minimum airflow.

6. Measure static pressure at the sensor.

7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.
C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems’ pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR DOMESTIC HOT WATER RECIRCULATION PLUMBING SYSTEMS

A. Set calibrated balancing valves at calculated pre-settings.

B. Measure flow at all stations and adjust, where necessary, to obtain first balance

C. Adjust balancing stations to within specified tolerances of indicated recirculation flow rate.

D. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

E. Record settings and mark balancing devices.

3.12 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.

D. Check the settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.13 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.14 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.15 PROCEDURES FOR BOILERS

A. If hydronic, measure entering- and leaving-water temperatures and water flow.
B. If steam, measure entering-water temperature and flow and leaving steam pressure, temperature, and flow.

3.16 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Electric-Heating Coils: Measure the following data for each coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Steam Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Refrigerant Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.17 PROCEDURES FOR COMMERCIAL KITCHEN HOODS

A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.
   1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
   3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.
   1. Check duct slopes as required.
   2. Verify that duct access is installed as required.
   3. Verify that point of termination is as required.
4. Verify that duct air velocity is within the range required.
5. Verify that duct is within a fire-rated enclosure.

D. Report deficiencies.
1. Check each laboratory fume hood for the capture and containment of smoke by using a hand-held emitting device. Observe the capture and containment of smoke flow pattern across the open face and inside the hood. Make adjustments necessary to achieve the desired results.

E. With the room and laboratory fume hoods operating at indicated conditions, perform an "as-installed" performance test of the laboratory fume hood according to ASHRAE 110. Test each laboratory fume hood(s) and document the test results.

3.18 PROCEDURES FOR EXHAUST HOODS
A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.

B. After balancing is complete, do the following:
1. Measure and record the static pressure at the hood exhaust-duct connection.
2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

3.19 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING AIR SYSTEMS
A. Perform a preconstruction inspection of existing equipment that is to remain and be reused (as listed on plans).
1. Measure and record the operating speed, airflow, and static pressure of each fan. For belt driven devices, identify and record sheave and belt information.
2. Check and record the condition of each motorized damper.
3. Measure and record the motor voltage and amperage. Compare the values to motor nameplate information. Record the motor RPM.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Obtain the appropriate fan curves and plot the operating points.
10. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies. Submit the report to the engineer prior to demolition or modification.
B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow by more than 5 percent, make equipment adjustments to achieve the calculated airflow rates. If 5 percent or less, equipment adjustments are not required.
   4. Air balance each air outlet.

3.20 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING HYDRONIC SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, flow, and pressure of each pump.
   2. Measure and record existing balance valve settings on terminal devices.
   3. Check the condition of each control valve on terminal devices.
   4. Measure and record the motor voltage and amperage. Compare the values to motor nameplate information. Record the motor RPM.
   5. Check bearings and other lubricated parts for proper lubrication.
   6. Obtain the appropriate pump curves and plot the operating points.
   7. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies. Submit the report to the engineer prior to demolition or modification.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. Bearings and other parts are properly lubricated.
   2. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated flow of the renovated work to the measured pump flows and determine the new pump speed.

2. If calculations increase or decrease the water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated water flow rates. If 5 percent or less, equipment adjustments are not required.

3. Water balance each terminal device.

3.21 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to +10%.
2. Air Outlets and Inlets: -5% to +5%.
3. Heating-Water Flow Rate: 0 to +10%.
4. Cooling-Water Flow Rate: 0 to +5%.
5. Domestic Hot Water Recirculation Flow Rate: 0 to +10%.

3.22 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.23 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers’ test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outside-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems and domestic hot water recirculation systems. Present each system with single-line diagram and include the following as applicable:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat coil static-pressure differential in inches wg.
   g. Cooling coil static-pressure differential in inches wg.
   h. Heating coil static-pressure differential in inches wg.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

G. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outside-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.
   o. Inlet steam pressure in psig.

H. Gas Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
   a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

   1. Unit Data:
      a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btuh.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btuh.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

L. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
g. Space temperature in deg F.

M. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Room or riser served.
      d. Coil make and size.
      e. Flowmeter type.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Entering-water temperature in deg F.
      c. Leaving-water temperature in deg F.
      d. Water pressure drop in feet of head or psig.
      e. Entering-air temperature in deg F.
      f. Leaving-air temperature in deg F.

N. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Unit make and model number.
      d. Compressor make.
      e. Compressor model and serial numbers.
      f. Refrigerant weight in lb.
      g. Low ambient temperature cutoff in deg F.
   2. Test Data (Indicated and Actual Values):
      a. Inlet-duct static pressure in inches wg.
      b. Outlet-duct static pressure in inches wg.
      c. Entering-air, dry-bulb temperature in deg F.
      d. Leaving-air, dry-bulb temperature in deg F.
      e. Condenser entering-water temperature in deg F.
      f. Condenser leaving-water temperature in deg F.
      g. Condenser-water temperature differential in deg F.
      h. Condenser entering-water pressure in feet of head or psig.
      i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in psig.
n. High-pressure-cutout set point in psig.
o. Suction pressure in psig.
p. Suction temperature in deg F.
q. Condenser refrigerant pressure in psig.
r. Condenser refrigerant temperature in deg F.
s. Oil pressure in psig.
t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. Kilowatt input.
x. Crankcase heater kilowatt.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

O. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Ratings.

2. Steam Test Data (Indicated and Actual Values):
   a. Inlet pressure in psig.
   b. Condensate flow rate in lb/h.

3. Primary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

P. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model and serial numbers.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.
      h. Required net positive suction head in feet of head or psig.
      i. Pump rpm.
      j. Impeller diameter in inches.
      k. Motor make and frame size.
      l. Motor horsepower and rpm.
      m. Voltage at each connection.
      n. Amperage for each phase.
      o. Full-load amperage and service factor.
      p. Seal type.

   2. Test Data (Indicated and Actual Values):
      a. Static head in feet of head or psig.
      b. Pump shutoff pressure in feet of head or psig.
      c. Actual impeller size in inches.
      d. Full-open flow rate in gpm.
      e. Full-open pressure in feet of head or psig.
      f. Final discharge pressure in feet of head or psig.
      g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.

i. Final water flow rate in gpm.

j. Voltage at each connection.

k. Amperage for each phase.

Q. Boiler Test Reports:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Fuel type and input in Btuh.
   g. Number of passes.
   h. Ignition type.
   i. Burner-control types.
   j. Voltage at each connection.
   k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):
   a. Operating pressure in psig.
   b. Operating temperature in deg F.
   c. Entering-water temperature in deg F.
   d. Leaving-water temperature in deg F.
   e. Number of safety valves and sizes in NPS.
   f. Safety valve settings in psig.
   g. High-limit setting in psig.
   h. Operating-control setting.
   i. High-fire set point.
   j. Low-fire set point.
   k. Voltage at each connection.
   l. Amperage for each phase.
   m. Draft fan voltage at each connection.
   n. Draft fan amperage for each phase.
   o. Manifold pressure in psig.

R. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. If fans are an integral part of the unit, include the following for each fan:
   a. Make and type.
   b. Arrangement and size.
   c. Sheave make, size in inches, and bore.
   d. Sheave dimensions, center-to-center, and amount of adjustments in inches.

4. Test Data (Indicated and Actual Values):
   a. Total exhaust airflow rate in cfm.
   b. Purge exhaust airflow rate in cfm.
   c. Outside airflow rate in cfm.
   d. Total exhaust fan static pressure in inches wg.
   e. Total outside-air fan static pressure in inches wg.
   f. Pressure drop on each side of recovery wheel in inches wg.
   g. Exhaust air temperature entering in deg F.
   h. Exhaust air temperature leaving in deg F.
   i. Outside-air temperature entering in deg F.
   j. Outside-air temperature leaving in deg F.
   k. Calculate sensible and total heat capacity of each airstream in MBh.

S. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
3.24 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Measure sound levels at two locations.
      e. Measure space pressure of at least 10 percent of locations.
      f. Verify that balancing devices are marked with final balance position.
      g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
   2. TAB firm test and balance engineer shall conduct the inspection in the presence of [Owner] [Architect].
   3. [Owner] [Architect] shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
   7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

e. Dates of calibration.
3.25 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 20 05 93
SECTION 20 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Calcium silicate.
   b. Cellular glass.
   c. Flexible elastomeric.
   d. Mineral fiber.
   e. Phenolic.
   f. Polyisocyanurate.
   g. Polyolefin.
   h. Polystyrene.

2. Fire-rated insulation systems.

3. Insulating cements.

4. Adhesives.

5. Mastics.


7. Sealants.

8. Factory-applied jackets.


10. Field-applied cloths.

11. Field-applied jackets.
MECHANICAL INSULATION

12. Tapes.
13. Securements.
15. Protective shielding guards

B. Related Sections:
   1. Division 23 Section 23 31 13 “Metal Ducts” for duct liners.

1.3 DEFINITIONS


C. CFC: Chlorinated Fluorocarbon.

D. HCFC: Hydrogenated Chlorofluorocarbon.

E. LEED: Leadership in Energy and Environmental Design.

F. MIL: Military.

G. NPS: Nominal Pipe Size.


1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.
   8. Detail field application for each equipment type.
C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:


1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 20 Section 20 05 29 “Hangers and Supports.”

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.
1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Industrial Insulation Group (The); Thermo-12 Gold.
   2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pittsburgh Corning Corporation; Foamglas.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.


7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armalax.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK or PSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
   b. Johns Manville; HTB 26 Spin-Glas.
   c. Roxul Inc.; Roxul RW.

K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJor FSK jacket (see duct application schedule on plans. For equipment applications, provide insulation with factory-applied ASJ jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CertaPro Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.
L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; FBX. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
   b. Rock Wool; Delta Board.
   c. Roxul Inc.; RHT and RockBoard.
   d. Thermafiber, Inc.; Thermafiber Industrial Felt.

M. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb./cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

O. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Styrofoam.
2.2 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

D. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:

   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polycro VP Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”
2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 501.
      d. Mon-Eco Industries, Inc.; 55-10.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180 deg F.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 570.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 550.
      e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.

2.6 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
b. Eagle Bridges - Marathon Industries; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
   4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.


4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.
      a. Finish and thickness are indicated in field-applied jacket schedules.
      b. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
      c. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 488 AWF.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      c. Compac Corporation; 120.
      d. Venture Tape; 3520 CW.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, Aluminum or Stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 316.
2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Truebro; a brand of IPS Corporation.
      b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Truebro; a brand of IPS Corporation.
      b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation (Conditioned Spaces): Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation (Unconditioned Spaces and Exposed to Weather): Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Division 07 "Penetration Firestopping" and fire-resistant joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 07 07 84 13 Section “Penetration Firestopping.”

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for [100] [50] percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 50 percent coverage of adhesive to surface with manufacturer’s recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from stainless steel, at least 0.050 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word “UNION.” Match size and color of pipe labels.

C. Provide protective shielding guards on exposed piping serving barrier free sinks and lavatories.

D. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
E. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer’s written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [100] [50] percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [100] [50] percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 EXTERNAL ACOUSTICAL DUCT LAGGING SYSTEM INSTALLATION

A. Board Insulation Installation for external ductwork lagging:

1. Provide lagging system where indicated on drawings.

2. For Mineral-Fiber Board lagging:

a. Secure a single layer of 1 inch mineral-fiber board with minimum 4-lb./cu. ft. density with lagging adhesive. Provide reinforcement angles two feet on center. Mineral-fiber board shall extend edges up to seams and reinforcements.

3. For Gypsum lagging for duct rumble:

b. Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws. Provide sheet metal screws with washer in head 18 inches on center. Provide reinforcement angles two feet on center. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.

c. Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws to metal stud framing. Provide 6 inches of air space around duct between the duct and metal framing to decouple the system. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.

3.12 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed section of polystyrene insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.13 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.
3.14 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material:
   Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material
      and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of
   insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection
   of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and
      insulation in layers in reverse order of their installation. Extent of inspection shall be limited
      to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

   2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-
      applied jacket and insulation in layers in reverse order of their installation. Extent of
      inspection shall be limited to one location for each type of equipment defined in the
      "Equipment Insulation Schedule" Article. For large equipment, remove only a portion
      adequate to determine compliance.

   3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing
      field-applied jacket and insulation in layers in reverse order of their installation. Extent of
      inspection shall be limited to three locations of straight pipe, three locations of threaded
      fittings, three locations of welded fittings, two locations of threaded strainers, two locations
      of welded strainers, three locations of threaded valves, and three locations of flanged
      valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals
   noncompliance with requirements.

3.16 BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be one of the following:
   1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb./cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb./cu. ft. nominal density.

B. Round, concealed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb./cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb./cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb./cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb./cu. ft. nominal density.

D. Rectangular, concealed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb./cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb./cu. ft. nominal density.

3.17 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.
3.18 INDOOR DUCT AND PLENUM INSULATION SCHEDULE
   A. Refer to “Duct Application Schedule” in the drawings.

3.19 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE
   A. Refer to “Duct Application Schedule” in the drawings.

3.20 EXTERNAL ACOUSTICAL DUCT LAGGING SCHEDULE
   A. System for prevention of sound transmission through metal ductwork in noise sensitive areas.
      1. Mineral-Fiber Board: Single layer 1 inch thick and 6-lb./cu. ft.
      2. Gypsum Board: Two layers 5/8 inch thick.

3.21 EQUIPMENT INSULATION SCHEDULE
   A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
   B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
   C. Domestic hot-water pump insulation shall be one of the following:
      1. Cellular Glass: 2 inches thick.
      3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
   D. Heating-hot-water pump insulation shall be one of the following:
      1. Calcium Silicate: 3 inches thick.
      2. Cellular Glass: 3 inches thick.
      3. Mineral-Fiber Board: 2 inches thick and 3-lb./cu. ft. nominal density.
   E. Steam condensate pump and boiler feedwater pump insulation shall be one of the following:
      1. Calcium Silicate: 3 inches thick.
      2. Cellular Glass: 3 inches thick.
      3. Mineral-Fiber Board: 2 inches thick and 3-lb./cu. ft. nominal density.
   F. Heating-hot-water expansion/compression tank insulation shall be one of the following:
      1. Calcium Silicate: 2 inches thick.
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3. Mineral-Fiber Board: 1 inch thick and 3-lb./cu. ft. nominal density.

G. Heating-hot-water air-separator insulation shall be one of the following:
   1. Calcium Silicate: 3 inches thick.
   2. Cellular Glass: 3 inches thick.
   3. Mineral-Fiber Board: 2 inches thick and 3-lb./cu. ft. nominal density.

H. Deaerator, steam condensate tank and receiver, steam flash-tank, flash-separator, and blow-off-tank insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb./cu. ft. nominal density.

3.22 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.23 INDOOR PIPING INSULATION SCHEDULE

A. Refer to "Piping Application Schedule" and "Plumbing Application Schedule" in the drawings.

B. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      b. Flexible Elastomeric: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 1 inch thick.

3.24 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refer to “Piping Application Schedule” and “Plumbing Application Schedule” in the drawings.

B. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 2 inches thick.
      b. Flexible Elastomeric: 2 inches thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 2 inches thick.
      b. Polyolefin: 2 inches thick.

3.25 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Refer to “Piping Application Schedule” and “Plumbing Application Schedule” in the drawings.

3.26 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Refer to “Duct Application Schedule”, “Piping Application Schedule” and “Plumbing Application Schedule” in the drawings.

B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

C. If more than one material is listed, selection from materials listed is Contractor's option.

END OF SECTION 20 07 00
SECTION 20 08 00 – COMMISSIONING OF MECHANICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This specification includes the commissioning process requirements for mechanical equipment, systems and assemblies.

B. Refer to Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 SCOPE OF COMMISSIONING

A. The following mechanical systems are to be commissioned and are identified by building:

1. Bates Academy
   i. Roof Top Unit
   ii. Power Ventilators
   iii. Split AC Units
   iv. Hot Water Cabinet Unit Heaters (Qty 25%)
   v. Hot Water Unit Heater (Qty 25%)
   vi. Hot Water Radiant Ceiling Panels (Qty 25%)
   vii. Hot Water Boiler
   viii. Circulation Pumps
   ix. Building Management System

2. John R. King
   i. Roof Top Units
   ii. Air Terminal Units (Qty 25%)
   iii. Air to Air Heat Exchangers
   iv. Air Cooled Condensing Unit
   v. Variable Refrigerant Flow Units (Qty 25%)
   vi. (E) Finned Tube Radiators (Qty 25%)
   vii. Building Management System

3. Henderson
   i. Roof Top Units
   ii. Air Terminal Units
   iii. Power Ventilators
   iv. Hot Water Boilers
   v. Circulation Pumps
   vi. Hot Water Unit Heaters (Qty 25%)
   vii. Hot Water Cabinet Unit Heaters (Qty 25%)
   viii. Finned Tube Radiators (Qty 25%)
   ix. Hot Water Radiant Ceiling Panel (Qty 25%)
   x. Building Management System

4. Mann
   i. Roof Top Units
   ii. Air to Air Heat Exchangers
   iii. Variable Refrigerant Flow Units
iv. Air Terminal Units (Qty 25%)
v. Power Ventilators (Qty 25%)
vi. Steam Boiler
vii. Condensate Return Unit
viii. Steam Unit Heater (Qty 25%)
ix. (E) Finned Tube Radiators (Qty 25%)
x. Building Management System

C. Refer to Division 01 Section "General Commissioning Requirements" for general commissioning scope.

1.4 DEFINITIONS
A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 DOCUMENTATION
A. Refer to Division 01 Section "General Commissioning Requirements" for documentation to be provided by the CxA.

A. Refer to Division 01 Section "General Commissioning Requirements" for documentation to be provided by the construction manager and contractor. In addition, provide the following:

1. Equipment Start Up Reports. See equipment specific specifications for Start Up requirements.

1.6 COORDINATION
A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to coordination during the commissioning process.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT
A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from the vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Temporary data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5F and a resolution of + or -
0.1F. Pressure sensors shall have an accuracy of \(+\) or \(-2.0\%\) of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 EXECUTION

3.1 STARTUP PLANS AND REPORTS

A. For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 2 weeks prior to startup.

B. For each item of equipment and system for which the manufacturer provides a startup report, document compliance by submitting the completed startup checklist and final startup report, signed and dated by the responsible entity.

3.2 PREFUNCTIONAL CHECKLISTS

A. A Prefunctional Checklist is required to be filled out for each item of equipment or system to be commissioned.

1. These checklists do not replace manufacturer’s recommended startup checklists regardless of apparent redundancy.

2. The following types of information will be gathered via the completed Prefunctional Checklist forms:
   a. Certification by installing contractor that the unit is properly installed, started up, operating, and ready for Functional Testing.
   b. Manufacturer, model number, and relevant capacity information. List information “as installed.”
   c. Serial number of installed unit.

B. Contractor is responsible for filling out Prefunctional Checklists after completion of installation and before operational startup. Witness of operational startup by the Commissioning Authority is not required unless otherwise specified.

1. Each line item is to be initialed and dated by the Contractor. Checklists are not complete until all line items are initialed and dated without deficiencies.

2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing. Re-submission of the Checklist is required upon completion of remaining items.

3. Individual Checklists may contain line items that are the responsibility of more than one installer. Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.

4. If any Checklist line item is not relevant, record reasons on the form.

5. Contractor may independently perform startup inspections and/or tests at Contractor's option.

6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.

7. Submit completed Checklists to Commissioning Authority within two days of completion.

C. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.

1. Provide all additional information requested by Commissioning Authority to aid in preparation of Checklists, such as shop drawing submittals, manufacturer’s startup checklists, and operation & maintenance data.
2. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in Contract Documents or not.

D. Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

D. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.3 FUNCTIONAL TESTS

A. A Functional Test is required for EACH item of equipment, system, or other assembly specified to be commissioned unless SAMPLING of multiple identical units is allowed by the final test procedures.

B. Contractor is responsible for execution of required Functional Tests after completion of Prefunctional Checklists and before closeout.

C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation of forms for that purpose.

D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner. If a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and record the Contractor’s stated intentions for correction.

1. Deficiencies are any condition in the installation or function of a component, piece of equipment, or system that is not in compliance with Contract Documents or does not perform properly.

2. When the deficiency has been corrected, the Commissioning Authority will reschedule the test and the Contractor shall re-test.

3. If 10 percent of identical items fail to perform due to materials or manufacturing defect, all items will be considered defective. Contractor shall provide a proposal for correction within 2 weeks after notification of defect.

4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time to witness re-testing.

E. Functional Test Procedures:

1. Examples of Functional Testing:
   a. Test the dynamic function of equipment and systems using direct observation and/or monitoring methods under full operation.
   b. Systems are tested under various conditions such as high heating/cooling loads, low heating/cooling loads, component failures, unoccupied mode, fire alarm, power failure, etc.
   c. Systems are subjected to all controls and building automation system sequences of operation. Components are verified to respond accordingly.

F. Deferred Functional Tests: Some tests may need to be performed after substantial completion due to partial occupancy, seasonal requirements, or other site conditions. Performance of these tests remains the Contractor’s responsibility regardless of timing.

3.4 SENSOR AND ACTUATOR CALIBRATION

A. Calibrate all field-installed temperature, relative humidity, carbon dioxide, pressure sensors, gauges, and actuators. Unit factory-installed sensors with calibration certification do not require field calibration.

B. Calibrate using the methods described below. Alternate methods may be used, if approved by Commissioning Authority and Owner beforehand.

C. Sensors:
1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
2. Verify that sensors with shielded cable are grounded only at one end.
3. Conduct reading with calibrated test instrument within 6 inches of the site sensor.
4. Verify that the sensor reading, via the permanent thermostat, gauge or building automation system, is within the tolerances of table below.

D. Sensor Tolerances

1. Watthour, Voltage, Amperage: 1 percent of design.
2. Pressure: 3 percent of design.
3. Temperature: 0.4 degrees F of design.
4. Relative Humidity: 4 percent of design.
5. Barometric Pressure: 0.1 inch Hg of design.
6. Flow Rate, air: 10 percent of design.
7. Flow Rate, water: 4 percent of design.
8. Flow Rate, steam: 3 percent of design.
9. Wet Bulb and Dew Point: 2.0 degrees F of design.
10. Water Temperature: 0.4 degrees F of design.
11. Oxygen and CO2 Monitors: 0.1 percent of design.

E. Valve/Damper Stroke Setup and Checkout

1. For all valve/damper actuator positions, verify the actual position against the control system readout.
2. Set pump/fan to normal operating mode.
3. Command valve/damper closed, visually verify that valve/damper is closed, and adjust output zero signal as required.
4. Command valve/damper to open, verify position is full open, and adjust output signal as required.
5. Command valve/damper to a multiple intermediate positions.

3.5 TEST PROCEDURES – GENERAL

A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

B. Provide all necessary materials and system modifications required to produce flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test conditions.

C. Identical Units

1. Identical units are defined as those with the same application and sequence of operation except for minor size or capacity differences.
2. Where sample Functional Testing of identical units is permitted, test 25% of the project total. If half of these units fail Functional Testing, all units (i.e. 100% of the project total) shall be inspected and issues remediated by the Contractor. Thereafter, all units (i.e. 100% of the project total) shall undergo Functional Testing.
3. Sampling is not allowed for:
   a. Major equipment.
   b. Life-safety-critical equipment.
D. For Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance.

E. For Simulated Conditions: Artificially create the necessary condition for the purpose of testing the response of a system.

F. For Over-Writing Values: Change the sensor value known to the control system to see the response of the system.

G. For Indirect Indicators: Observe a response or condition indirectly from a control system screen or other device.

H. For Monitoring: Record parameters of equipment operation using trending capabilities of the control system. Where monitoring of specific points is called for in Functional Testing, complete the following:
   1. Provide hard copies of monitored data in columnar format.
   2. Alternately, provide graphical output if producible by the system.

3.6 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 XXXX - Closeout Submittals for additional requirements.

B. Contractor provides final operation & maintenance manuals of commissioned equipment to the Commissioning Authority for review. Contractor makes changes recommended by the Commissioning Authority.

3.7 DEMONSTRATION AND TRAINING

A. Contractor submit training plan for Owner personnel to the Commissioning Authority for review and approval.

B. Contractor coordinate scheduling of specified training sessions with invitations to the Commissioning Authority.

C. Contractor provide sign-in sheet and agenda for each training session along with copies of training aids and documentation to the Commissioning Authority for review.

END OF SECTION 20 08 00
SECTION 22 05 23 - VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2  SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Steel ball valves.
   3. Iron ball valves.
   5. Iron, grooved-end butterfly valves.
   7. Bronze swing check valves.
  10. Iron swing check valves with closure control.
  13. Iron, plate-type check valves.
  15. Iron gate valves.

B. Related Sections:
   1. Division 20 "Mechanical Identification" for valve tags and schedules.
   2. Division 22 "Facility Water Distribution Piping" for valves applicable only to this piping.
3. Division 22 “Domestic Water Piping” for valves applicable only to this piping.
4. Division 22 “Sanitary Waste Piping Specialties” for valves applicable only to this piping.
5. Division 22 “Storm Drainage Piping Specialties” for valves applicable only to this piping.
6. Division 22 “General-Service Compressed-Air Piping” for valves applicable only to this piping.
7. Division 33 “Storm Utility Drainage Piping” for valves applicable only to this piping.
8. Division 33 “Subdrainage” for valves applicable only to this piping.

1.3 DEFINITIONS

A. ASME: American Society of Mechanical Engineers.
D. CWP: Cold working pressure.
E. EPDM: Ethylene propylene copolymer rubber.
F. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
G. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
H. NRS: Nonrising stem.
I. OS&Y: Outside screw and yoke.
J. PTFE: Polytetrafluoroethylene plastic.
K. RS: Rising stem.
L. SWP: Steam working pressure.
M. TFE: Tetrafluorethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and soldered ends.
4. Set butterfly valves closed or slightly open.
5. Set check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
6. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. RS Valves in Insulated Piping: With 2-inch stem extensions.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Ball Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

K. Butterfly Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

L. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES
A. Two-Piece, Bronze Ball Valves with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Lance Valves.
   d. Milwaukee Valve Company.
   e. Nibco.
   f. Watts.
2. Description:
   b. CWP Rating: 600 psig.
   c. Body Design: Two piece.
   d. Body Material: Bronze.
   e. Ends: Threaded or soldered.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel, vented.
   i. Port: Full.

B. Two-Piece, Safety-Exhaust, Bronze Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries; Apollo Valves.
b. Jamesbury; Metso.
c. Nibco.

2. Description:
   b. CWP Rating: 600 psig.
   c. Body Design: Two piece.
   e. Ends: Threaded.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
   i. Port: Full.

2.3 STEEL BALL VALVES

A. Class 150, Steel Ball Valves with Full Port:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries; Apollo Valves.
      b. Jamesbury; Metso.
      c. Nibco.
   2. Description:
      d. Body Material: Carbon steel, ASTM A 216, Type WCB.
      e. Ends: Flanged or threaded.
      f. Seats: PTFE.
      g. Stem: Stainless steel.
      h. Ball: Stainless steel, vented.
      i. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve.
b. Conbraco Industries; Apollo Valves.
c. Kitz Corporation.
d. Sure Flow Equipment.
e. Watts.
f. Zurn Industries.

2. Description:
   b. CWP Rating: 200 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged or threaded.
   f. Seats: PTFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls
      b. American Valve.
      c. Conbraco Industries.; Apollo Valves.
      d. Crane Co.; Crane Valve Group; Jenkins Valves.
      e. DeZurik
      f. Flo Fab
      g. FNW; Ferguson Enterprises, Inc.
      h. Hammond Valve.
      i. Jenkins Valves; a Crane Co. brand.
      j. Kitz Corporation
      k. Legend Valve
      l. Milwaukee Valve Company.
      m. Mueller Steam Specialty.
      n. Nibco.
      o. Norriseal.
2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating, NPS 12 and Smaller: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Stainless steel.

2.6 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES
A. 300 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International.
      b. Kennedy Valve Company.
      c. Mueller Steam Specialty
      d. NIBCO
      e. Shurjoint Piping Products.
      f. Tyco Fire Products.
      g. Victaulic Company.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating, NPS 8 and Smaller: 300 psig.
      c. CWP Rating, NPS 10 and Larger: 200 psig.
      d. Body Material: Coated, ductile iron.
      e. Stem: Two-piece stainless steel.
      f. Disc: Coated, ductile iron.
      g. Seal: EPDM [NBR].

2.7 BRONZE LIFT CHECK VALVES
A. Bronze Lift Check Valves with Bronze Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded or soldered. See valve schedule articles.
   f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flo Fab Inc.
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. Mueller Steam Specialty; a division of SPX Corporation.
   f. NIBCO INC.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded or soldered. See valve schedule articles.
   f. Disc: NBR, PTFE.

2.8 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded or soldered. See valve schedule articles.
   f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded or soldered. See valve schedule articles.
      f. Disc: PTFE.

2.9 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Sure Flow Equipment Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged or threaded. See valve schedule articles.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

B. Iron Swing Check Valves with Metal Seats, Class 250:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 500 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300 CWP:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Shurjoint Piping Products.
      c. Tyco Fire Products LP; Grinnell Mechanical Products.
      d. Victaulic Company.
   2. Description:
      a. CWP Rating: 300 psig.
      c. Seal: EPDM.
      d. Disc: Spring operated, ductile iron or stainless steel.

2.11 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

A. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 250:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Flo Fab Inc.
      e. Hammond Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Sure Flow Equipment Inc.
      i. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. CWP Rating: 400 psig.
      d. Style: Compact wafer, spring loaded.
e. Seat: EPDM or NBR.

B. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 250:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. APCO Willamette Valve and Primer Corporation.
      b. Crispin Valve.
      c. DFT Inc.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Val-Matic Valve & Manufacturing Corp.
   2. Description:
      b. CWP Rating: 400 psig.
      d. Style: Globe, spring loaded.
      e. Ends: Flanged.
      f. Seat: EPDM or NBR.

2.12 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 150:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Hammond Valve.
      c. Kitz Corporation.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Powell Valves.
      g. Red-White Valve Corporation.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 300 psig.
d. Ends: Threaded.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

2.13 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Crane; a Crane brand.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Powell Valves.
   g. Stockham; a Crane Co. brand.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 500 psig.
   c. Body Material: Gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.14 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Babbitt Steam Specialty.
   2. Roto Hammer Industries.
   3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve.
2. Chain: Hot-dip, galvanized steel or Stainless steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for damage or conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

G. Install valve tags. Comply with requirements in Section 20 “Mechanical Identification” for valve tags and schedules.
3.3 ADJUSTING
A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS
A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or gate valves.
   2. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. Use gate valves for shutoff service only.

C. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

D. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE
A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Two-piece, bronze ball valves with full port and stainless-steel trim.
   3. Bronze swing check valves with bronze disc, Class 150, with soldered end connections.
   4. Bronze gate valves, NRS, Class 150 with soldered ends.

B. Pipe NPS 2-1/2 and Larger:
   1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Class 150, steel ball valves with full port.
   3. Class 150, iron ball valves.
4. Iron, center-guided check valves with globe, resilient seat, Class 250, with threaded or flanged end connections.

5. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 250 with flanged ends.

C. Butterfly Valves:
   2. Ductile-Iron, Grooved-End Butterfly Valves: 300 CWP.

END OF SECTION 22 05 23
SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Division 22 Section 22 11 13 “Facility Water Distribution Piping” for water-service piping[ and water meters] outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

B. Coordination Drawings: Piping in congested areas such as mechanical rooms, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Sanitary and vent piping.
2. Storm drainage piping.
3. HVAC hydronic piping.
4. Ductwork systems.
5. Building structural systems.
6. Electrical raceway systems.
7. Electrical equipment working space and clearances.
8. Items penetrating finished ceiling include the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Fire alarm devices.
   e. Audio visual equipment.

1.4 INFORMATION SUBMITTALS
A. Water Samples: Specified in "Cleaning" Article.
B. System purging and disinfecting activities report.
C. Field quality-control reports.
D. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

1.6 PROJECT CONDITIONS
A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Construction Manager's written permission.

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L \[\text{water tube, drawn temper.}\]

B. Soft Copper Tube: ASTM B 88, Type K \[\text{water tube, annealed temper.}\]


D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
   1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51.
   2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.


2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural

2.6 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Piping Specialties Products.
      c. Ford Meter Box Company, Inc. (The).
      e. JCM Industries.
      f. Romac Industries, Inc.
      g. Smith-Blair, Inc.; a Sensus company.
      h. Viking Johnson.

2.7 DIELECTRIC FITTINGS
   A. General Requirements: Assembly of copper alloy and ferrous materials with separating
      nonconductive insulating material. Include end connections compatible with pipes to be joined.
   B. Comply with the requirements of Division 20 Section 20 05 00 “Common Work Results.”

2.8 ESCUTCHEONS
   A. Refer to Division 20 Section 20 05 00 Section “Common Work Results” for requirements.

2.9 SLEEVES
   A. Refer to Division 20 Section 20 05 00 Section “Common Work Results” for requirements.

2.10 SLEEVE SEALS
   A. Refer to Division 20 Section 20 05 00 Section “Common Work Results” for requirements.

2.11 GROUT
   A. Refer to Division 20 Section 20 05 00 Section “Common Work Results” for requirements.
PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 Section 22 05 19 “Meters and Gages for Plumbing Piping” and with requirements for drain valves and strainers in Division 22 Section 22 11 19 "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 Section 22 11 19 "Domestic Water Piping Specialties."

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter re-installation according to utility company’s requirements.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.
Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section 22 05 19 "Meters and Gages for Plumbing Piping."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section 22 11 23 "Domestic Water Pumps."

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section 22 05 19 "Meters and Gages for Plumbing Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors.

V. Install sleeve seals for piping penetrations of concrete walls and slabs.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors.

X. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top or side of the main pipe.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Comply with the requirements of Division 20 Section 20 05 00 “Common Work Results.”

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Division 20 Section 20 05 29 "Hangers and Supports for Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. .

E. Install supports for vertical copper tubing every 10 feet.
3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Comply with the requirements of Division 20 Section 20 05 00 “Common Work Results.”

3.8 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. Comply with the requirements of Division 20 Section 20 05 00 “Common Work Results.”

3.9 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 20 Section 20 05 53 "Mechanical Identification."

B. Label pressure piping with system operating pressure.

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and un Concealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.
B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Refer to “Plumbing Piping System Application Schedule” in drawings.

3.15 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Provide check valve on branch piping downstream of hot water circulation balancing valve.

END OF SECTION 22 11 16
SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Vacuum breakers.
   2. Backflow preventers.
   5. Temperature-actuated, water mixing valves.
   7. Hose bibs.
   8. Wall hydrants.
  10. Water-hammer arresters.
  11. Air vents.
  12. Trap-seal primer valves.
  13. Flexible connectors.

B. Related Requirements:
   1. Division 22 Section 22 05 19 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
   2. Division 22 Section 22 47 00 "Drinking Fountains & Electric Water Coolers" for water filters for water coolers.
1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 WATER METER

A. Contractor shall carry an allowance to re-install existing water meter as determined by the construction manager based on coordination with the local utility company.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 372

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Conbraco Industries, Inc.
      c. FEBCO; a division of Watts Water Technologies, Inc.
      d. Toro Company (The); Irrigation Div.
      e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated for exposed finished areas. Rough bronze for unfinished areas.

B. Hose-Connection Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. MIFAB, Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   f. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
5. Finish: **Chrome or nickel plated**

C. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Toro Company (The); Irrigation Div.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Design Flow Rate: See plans.
6. Body: Bronze for NPS 2 and smaller; **stainless steel** for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

B. Double-Check, Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Design Flow Rate: See plans.
6. Body: Bronze for NPS 2 and smaller; **stainless steel** for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
   a. Valves: NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves: NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
C. Backflow-Preventer Test Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. FEBCO; a division of Watts Water Technologies, Inc.
      c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cash Acme; a division of Reliance Worldwide Corporation.
      b. Conbraco Industries, Inc.
      c. Honeywell International Inc.
      d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   4. Size: See plans.
   5. See plans. Design Outlet Pressure Setting: See plans
   6. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
   8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Flo Fab Inc.
      c. ITT Corporation; Bell & Gossett Div.
      d. NIBCO Inc.
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e. TAC.
f. TACO Incorporated.
g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: **Ball or Y-pattern globe** valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. NIBCO Inc.
   h. Red-White Valve Corp.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. Honeywell International Inc.
   e. Leonard Valve Company.
   f. Powers; a division of Watts Water Technologies, Inc.
   g. Symmons Industries, Inc.
   h. TACO Incorporated.
   i. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company
   j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: See plans.Retain "Tempered-Water Design Flow Rate" Subparagraph below only if flow rate is not indicated on Drawings.

B. Primary, Thermostatic, Water Mixing Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
e. Symmons Industries, Inc.


3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded union inlets and outlet.

7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Tempered-Water Setting: See plans

9. Tempered-Water Design Flow Rate: See plans

10. Pressure Drop at Design Flow Rate: See plans.

11. Valve Finish: Rough bronze.

12. Piping Finish: Copper.

13. Cabinet: Factory fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

C. Individual-Fixture, Water Tempering Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a division of Watts Water Technologies, Inc.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1070, thermostatically controlled, water tempering valve.

3. Pressure Rating: 125 psig minimum unless otherwise indicated.


5. Temperature Control: Adjustable.

6. Inlets and Outlet: Threaded.

7. Finish: Rough or chrome-plated bronze.

8. Tempered-Water Setting: See plans.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig minimum unless otherwise indicated.
   2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations unless otherwise indicated.
   5. Perforation Size:
      a. Strainers NPS 2 and Smaller: 0.020 inch.
      b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch

2.9 HOSE BIBBS

A. Hose Bibbs
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Rough bronze
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   12. Operation for Service Areas: Operating key
   13. Operation for Finished Rooms: Operating key
   14. Include operating key with each operating-key hose bibb.
   15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products.
   f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   h. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.


4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.


7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounted with cover.

9. Box and Cover Finish: Polished nickel bronze


11. Nozzle and Wall-Plate Finish: Polished nickel bronze

12. Operating Keys(s): One with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:


2. Pressure Rating: 400-psig minimum CWP.


4. Body: Copper alloy.

5. Ball: Chrome-plated brass.


8. Inlet: Threaded or solder joint.

B. Gate-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: Class 125.
   5. Inlet: NPS 3/4 threaded or solder joint.
   6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
   1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
   2. Pressure Rating: 200-psig minimum CWP or Class 125.
   5. Drain: NPS 1/8 side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Precision Plumbing Products, Inc.
      e. Sioux Chief Manufacturing Company, Inc.
      g. Tyler Pipe; Wade Div.
      h. Watts Drainage Products.
      i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
   1. Body: Bronze.
   2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.

B. Welded-Construction Automatic Air Vents:
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.

2.14 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   c. Zurn

2.15 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 20 20 05 23 “General-Duty Valves for Piping.”

B. Spring Operated, Diaphragm Assist Safety Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett Domestic Pump; a division of Xylem, Inc.
      d. Conbraco Industries, Inc.
      e. Spence Engineering Company, Inc.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Body: Brass.
   3. Disc: Glass and carbon-filled PTFE.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
   9. Spring: Alloy steel
   10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
   11. Maximum Temperature Rating of 250 deg F.

2.16 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.
   4. Flex-Weld Incorporated.
   5. Hyspan Precision Products, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex. Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install individual fixture temperature-actuated, water mixing valves on each lavatory/sink designated for hand washing.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each pump.
G. Install water-hammer arresters in water piping according to PDI-WH 201.

H. Install air vents at high points of water piping. **Install drain piping and discharge onto floor drain.**

I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

L. Install waterless trap-seal systems in floor drains per manufacturer recommendations.

M. Install flexible hose connections on inlet and outlet of each pump and water service connections to vibration producing mechanical equipment.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified elsewhere in project manual.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
5. Calibrated balancing valves.
6. Primary, thermostatic, water mixing valves.
8. Primary water tempering valves.
10. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying
unit. Nameplates and signs are specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19
SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.
1.6 DELIVERY, STORAGE, AND HANDLING
   A. Retain shipping flange protective covers and protective coatings during storage.
   B. Protect bearings and couplings against damage.
   C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS
   A. Pump Units: Factory assembled and tested.
   B. Motors: Comply with requirements in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment".
   C. Selection:
      1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
      2. Pump speed shall be limited to 1,800 RPM except as scheduled.
      3. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
      4. Maximum impeller diameter shall not be greater than 90 percent of "cut water" diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
      5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
      6. Select pump at a point no greater than 85 percent of end of curve flow.
      7. Maximum pump suction velocity:
         a. In-line: 12 fps.

2.2 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Armstrong Pumps Inc.
DOMESTIC WATER PUMPS

2. Bell & Gossett Domestic Pump; ITT Corporation.
3. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
4. Pentair Pump Group; Aurora Pump.
5. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:
   1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
   3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
   4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
   5. Bearings: Oil-lubricated; bronze-journal or ball type.
   6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics: Refer to drawing schedule.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20.05.13 "Common Motor Requirements for Equipment."

   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Pressure Switches: Electric, adjustable for control of water-supply pump.

   1. Type: Water-immersion pressure sensor, for installation in piping.
   2. Enclosure: NEMA 250, Type 4X
   3. Operation of Pump: On or off.
   4. Transformer: Provide if required.
   5. Power Requirement: **24 V, ac**

B. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F
3. Enclosure: NEMA 250, Type 4X
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: **24 V, ac**
7. Settings: Start pump at 120 deg F and stop pump at 130 deg F Retain "Timers" Paragraph below if applying controls to limit hot-water circulation pump operation to periods when hot water is required, which is required by LEED v4, IgCC, and ASHRAE 189.1.

C. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
   1. Type: Adjustable time-delay relay.
   2. Range: Up to five minutes.
   4. Enclosure: NEMA 250, Type 4X
   5. Operation of Pump: On or off.
   6. Transformer: Provide if required.
   7. Power Requirement: **24-V ac**
   8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION
   A. Comply with HI 1.4.
   B. Mount pumps in orientation complying with manufacturer's written instructions.
   C. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
   D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
   E. Install continuous-thread hanger rods and **spring hangers** of size required to support pump weight.
1. Comply with requirements for hangers and supports specified in Division 20 Section 20 05 29 "Hangers and Supports for Piping and Equipment."

F. Install pressure switches in water supply piping.

G. Install thermostats in hot-water return piping.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
   1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
      b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
      c. Vertically mounted, in-line, close-coupled centrifugal pumps.
      d. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."

2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 22 11 19 "Domestic Water Piping Specialties."

3. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Connect [pressure switches,] [thermostats,] [time-delay relays,] [and] [timers] to pumps that they control.

D. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.
3.5 IDENTIFICATION
A. Identify system components. Comply with requirements for identification specified in Section 20 05 53 "Mechanical Identification" for identification of pumps.

3.6 FIELD QUALITY CONTROL
A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
D. Perform tests and inspections.
E. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

3.7 STARTUP SERVICE
A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
   5. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23
SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS


B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

D. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Coordination Drawings: Detail sanitary waste and vent piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which drainage piping will be attached or suspended from.

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

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.


1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:


2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, stamped with the Cast Iron Soil Pipe Institute trademark, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.
2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 and CISPI 301 stamped with the Cast Iron Soil Pipe Institute trademark. Pipe shall be cast vertically or by centrifugal process and the inside and outside diameters shall be concentric, smooth, and free from cracks, sand holes, and other defects.

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company
      c. Fernco Inc.
      d. Ideal Clamp Products
      e. Josam Company.
      f. MIFAB, Inc.
      g. Mission Rubber Company; a division of MCP Industries, Inc.
      h. Tyler Pipe; a subsidiary of McWane Inc.
   2. Couplings shall bear CISPI collective trademark[ and NSF certification mark.
   4. Description: Stainless-steel corrugated shield with a minimum of four stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS


B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 SPECIALTY PIPE FITTINGS
   A. Specialty pipe fitting requirements are specified in Section 20 20 05 13 "Common Work Results."

PART 3 - EXECUTION

3.1 EARTH MOVING
   A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
      1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
      2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
   B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   E. Install piping to permit valve servicing.
   F. Install piping at indicated slopes.
G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

J. Install piping to allow application of insulation.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
   2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.
   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the minimum slopes required by code.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. PVC pipe shall not be exposed in return air plenums. Provide fire rated insulation as necessary for piping to comply with code required flame spread index and smoke-developed index when located within a return air plenum.

R. Install underground PVC piping according to ASTM D 2321.

S. Install engineered soil and waste drainage and vent piping systems as follows:
   2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

T. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping.

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section 221319 "Sanitary Waste Piping Specialties."

U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section Division 20 Section 20 05 13 "Common Work Results for Mechanical."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 20 Section 20 05 13 "Common Work Results for Mechanical."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 20 Section 20 05 13 "Common Work Results for Mechanical."

3.3 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Specialty pipe fitting installation requirements are specified in Division 20 Section 20 05 13 "Common Work Results for Mechanical."
3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 20 20 05 29 "Hangers and Supports for Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
      Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4: 60 inches with 5/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
   6. Equipment: Connect drainage piping as indicated. Use flanges instead of unions for connections NPS 2-1/2 and larger.

C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

D. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrive for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.
3.10  PIPING SCHEDULE

A. Refer to “Plumbing Piping System Application Schedule” in drawings.

B. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

END OF SECTION 22 13 16
SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Cleanouts.
   2. Floor drains.
   3. Air-admittance valves.
   4. Roof flashing assemblies.
   5. Through-penetration firestop assemblies.
   7. Flashing materials.

B. Related Requirements:
   1. Section 22 14 23 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.

1.3 DEFINITIONS


B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.
F. PVC: Polyvinyl chloride plastic.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."
B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS
A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.
2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M.
   3. Size: Same as connected drainage piping
   5. Closure: Countersunk brass plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Oatey.
      c. Sioux Chief Manufacturing Co., Inc.
      e. Tyler Pipe.
      f. Watts Water Technologies, Inc.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Heavy-duty, adjustable housing
   5. Body or Ferrule Material: Cast iron.
   6. Clamping Device: Required
   7. Outlet Connection: Spigot
   8. Closure: Brass, bronze or plastic with tapered threads
   9. Adjustable Housing Material: Cast iron with threads, set-screws or other device
   10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
11. Frame and Cover Shape: Round
12. Top-Loading Classification: Medium Duty
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M. Include wall access.
   3. Size: Same as connected drainage piping.
   4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk, drilled-and-threaded brass or bronze plug with tapered threads.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 FLOOR DRAINS
A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Light Commercial Products Operation.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.3
   4. Body Material: Gray iron
   5. Seepage Flange: Required.
   6. Anchor Flange: Not required
   7. Clamping Device: Required
8. Outlet: Bottom
9. Backwater Valve: Not required Coating in first subparagraph below is usually used only on sanitary floor drains.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel
11. Sediment Bucket: Not required
12. Top or Strainer Material: Nickel bronze
13. Top of Body and Strainer Finish: Nickel bronze
14. Top Shape: Round
15. Top Loading Classification: Medium-Duty Drains located in Corridors and other occupied spaces shall be heavy duty loading.
16. Funnel: Not required
17. Inlet Fitting: Not required
18. Trap Material: Cast iron
19. Trap Pattern: Deep-seal P-trap
20. Trap Features: Trap-seal primer valve drain connection

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Oatey.
   b. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

2.5 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Thaler Metal Industries Ltd.
   c. Zurn Industries, LLC.
2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   6. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

E. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected soil, waste, or vent piping.

2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft..
   2. Vent Pipe Flashing: 8 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.
B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 07 62 00 "Sheet Metal Flashing and Trim."

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 07 62 00 "Sheet Metal Flashing and Trim."

I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations. Comply with requirements in Section 07 07 84 13 "Penetration Firestopping."

J. Assemble open drain fittings and install with top of hub 1 inch above floor.

K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
O. Install vent caps on each vent pipe passing through roof.

P. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

R. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

S. Install wood-blocking reinforcement for wall-mounting-type specialties.

T. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 “Sanitary Waste and Vent Piping” for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Comply with requirements in Section 07 62 00 “Sheet Metal Flashing and Trim.”

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 07 62 00 “Sheet Metal Flashing and Trim.”
G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

H. Fabricate and install flashing and pans, sumps, and other drainage shapes.

I. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 20 20 05 53 "Identification for Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

   B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19
SECTION 22 14 13 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.3 DEFINITIONS


B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

D. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which drainage piping will be attached or suspended from.

B. Product Data: For each type of product indicated.
1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
   

1.7 FIELD CONDITIONS
   A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
      1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of storm-drainage service.
      2. Do not proceed with interruption of storm-drainage service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
      1. Storm Drainage Piping: 10-foot head of water.

2.2 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings:
      1. Marked with CISPI collective trademark and NSF certification mark.
      2. Class: ASTM A 74, Service class(es).
   
   B. Gaskets: ASTM C 564, rubber.
2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 and CISPI 301 stamped with the Cast Iron Soil Pipe Institute trademark. Pipe shall be cast vertically or by centrifugal process and the inside and outside diameters shall be concentric, smooth, and free from cracks, sand holes, and other defects.

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Fernco Inc.
      d. Ideal Clamp Products
      e. MIFAB, Inc.
      f. Mission Rubber Company; a division of MCP Industries, Inc.
      g. Tyler Pipe.
   2. Couplings shall bear CISPI collective trademark and NSF certification mark.
   4. Description: Stainless-steel corrugated shield with a minimum of four stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 PVC PIPE AND FITTINGS


B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SPECIALTY PIPE FITTINGS

A. Specialty pipe fitting requirements are specified in Division 20 Section 20 05 13 "Common Work Results."

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

J. Install piping to allow application of insulation.

K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
   1. Do not change direction of flow more than 90 degrees.
   2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.

2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

3. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the minimum slopes required by code.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install aboveground PVC piping according to ASTM D 2665.

P. PVC pipe shall not be exposed in return air plenums. Provide fire rated insulation as necessary for piping to comply with code required flame spread index and smoke-developed index when located within a return air plenum.

Q. Install underground PVC piping according to ASTM D 2321.

R. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
      a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
      b. Comply with requirements for cleanouts specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."

   2. Install drains in storm drainage gravity-flow piping.
      a. Comply with requirements for drains specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."

S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 20 05 13 "Common Work Results."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 20 Section 20 05 13 "Common Work Results."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 20 Section 20 05 13 "Common Work Results."

3.2 JOINT CONSTRUCTION


C. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

D. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

E. Joint Restraints and Sway Bracing:
   1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
      a. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
      b. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Specialty pipe fitting installation requirements are specified in Division 20 Section 20 05 13 "Common Work Results."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 20 Section 20 05 29 "Hangiers and Supports for Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
L. Install supports for vertical PVC piping every 48 inches.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Comply with requirements for cleanouts and drains specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Refer to “Plumbing Piping System Application Schedule” in drawings.

END OF SECTION 22 14 13
STORM DRAINAGE PIPING
SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
B. Related Requirements:
   1. Division 07 Section 076200 “Sheet Metal Flashing and Trim” for penetrations of roofs.
   2. Division 07 Section 078413 “Penetration Firestopping” for firestopping roof penetrations.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe.
   e. Wade; a subsidiary of McWane Inc.
   f. Watts Water Technologies, Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.4, for general-purpose roof drains.


4. Dimension of Body: Nominal 14- to 16-inch diameter.

5. Combination Flashing Ring and Gravel Stop: Required

6. Flow-Control Weirs: Not required

7. Outlet: Bottom

8. Extension Collars: Required

9. Underdeck Clamp: Required

10. Expansion Joint: Not required

11. Sump Receiver Plate: Required

12. Dome Material: Cast iron or ductile iron

13. Perforated Gravel Guard: Stainless steel


15. Water Dam: Required for overflow drains only. 2 inches high.

16.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.

2. Size: Same as connected conductor.
2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Josam Company.
      c. MIFAB, Inc.
      d. Tyler Pipe; a subsidiary of McWane Inc.
      e. Wade; a subsidiary of McWane Inc.
      f. Watts; a Watts Water Technologies company.
      g. Zurn Industries, LLC.
   2. Standard: ASME A112.36.2M.
   3. Size: Same as connected branch.
   4. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk plug.
   6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

B. Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe; a subsidiary of McWane Inc.
      f. Wade; a subsidiary of McWane Inc.
      g. Watts; a Watts Water Technologies company.
      h. Zurn Industries, LLC.
   2. Standard: ASME A112.36.2M, for heavy-duty, adjustable housing cleanouts.
   3. Size: Same as connected branch.
   4. Type: Heavy-duty, adjustable housing.
   5. Body or Ferrule Material: Cast iron
   7. Outlet Connection: No hub
   8. Closure: Brass, bronze or plastic with tapered threads
   9. Adjustable Housing Material: Cast iron with threads, set-screws or other device
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy in finished areas provide a recessed cover for finished floor material.

11. Frame and Cover Shape: Round


13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. Wade; a subsidiary of McWane Inc.
   f. Watts Water Technologies, Inc.
   g. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded brass or bronze plug with tapered threads.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.


D. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. Watts; a subsidiary of McWane Inc.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.

3. Size: Same as connected drainage piping.

4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.

5. Closure Plug: Countersunk, brass
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer’s written installation instructions.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 18 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install test tees in vertical conductors and near floor.

I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

J. Assemble channel drainage system components according to manufacturer’s written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
   1. Comply with requirements in Division 07 Section 07 84 13 “Penetration Firestopping.”
L. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section 22 14 13 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23
SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
   C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
   D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.
   E. 

1.2 SUMMARY
   A. Section Includes:
      1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
      2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Sustainable Design Submittals:
      1. Product Data: For energy efficiency.
   C. Shop Drawings:
      1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
   A. Product Certificates: For each type of commercial, gas-fired domestic-water heater, from manufacturer.
   B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.  
   1. Comply with efficiency requirements in ASHRAE 189.1, which supersedes requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance:  
   1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.  
   1. Failures include, but are not limited to, the following:  
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
      1) Storage Tank: Five years.
      2) Controls and Other Components: One year(s).
   b. Expansion Tanks: One year.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-Fired, STORAGE, domestic-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Lochinvar Corporation.
      c. PVI Industries, LLC.
      d. RBI Water Heaters; a Mestek company.
      e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      f. State Industries.
   3. Description: Manufacturer’s proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
      a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
         2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
      b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   5. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
      c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

e. Jacket: Steel with enameled finish.

f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.

g. Temperature Control: Adjustable thermostat.

h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Direct Vent/sealed combustion.

B. Capacity and Characteristics: Refer to schedule on drawings.

2.2 domestic-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL Inc.
   b. ITT Industries; Bell & Gossett.
   c. Pentair Pump Group (The); Myers.
   d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   e. State Industries.
   f. Taco, Inc.
   g. Wessels Co.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 ANNEX G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics: Refer to schedule on drawings.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1
C. Heat-Trap Fittings: ASHRAE 90.2.

D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [calibrated] [memory-stop] balancing valves to provide balanced flow through each domestic-water heater.
   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Division 22 Section 22 11 19 "Domestic Water Piping Specialties."


F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.


H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

2.3 VENTING KITS

A. All venting material by Contractor: Refer to "Breechings, Chimneys, and Stack" Section for requirements.

B. Combustion-Air Intake: Complete system, CPVC pipe or material as specified in "Metal Ducts", vent terminal with screen, inlet air coupling, and sealant.

C. Exhaust shall be AL29-4C stainless steel.

D. Kit: Complete system, ASTM A 959, Type AL29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section 01 73 00 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 domestic-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.

2. Maintain manufacturer's recommended clearances.

3. Arrange units so controls and devices that require servicing are accessible.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

7. Install anchor bolts to elevations required for proper attachment to supported equipment.

8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section 22 05 23 "General-Duty Valves for Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section 23 11 23 "Facility Natural-Gas Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section 22 11 19 "Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 20 Section 20 05 19 "Meters and Gages for Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section 22 05 19 "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water expansion tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 23 Section 23 11 23 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.
3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 22 34 00
SECTION 22 42 00 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Water closet flushometer valves.
   3. Toilet seats.
   4. Lavatories.
   5. Lavatory Faucets.
   8. Sink faucets.
   10. Waste fittings.
   11. Supports.

1.3 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.
1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.5 CLOSEOUT SUBMITTALS
A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.
B. Operation and Maintenance Data: For flushometer valves, lavatories and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in Division 01 Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. Servicing and adjustments of automatic faucets and flush valves.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but not less than 2 total
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed, but not less than 2 total.
   3. Flushometer-Valve Repair Kits: Equal to percent of amount of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS
A. Water Closets: Floor mounted, bottom outlet, top spud.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Kohler Co.
      c. Sloan Valve Company.
      d. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Bowl:
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Style: Flushometer valve.
e. Height: Handicapped/elderly, complying with ICC/ANSI A117.1 or Standard height. Refer to architectural plans.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; top.
i. Color: White.

3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets: Wall mounted, top spud, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Kohler Co.
   c. Sloan Valve Company.
   d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Bowl:

   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: Standard.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.6 gal.1.28 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2; top.
   i. Color: White.


4. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1 or Standard. Refer to architectural plans.

2.3 WATER CLOSET FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Coyne & Delany Co.
   b. Sloan Valve Company.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.

4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
7. Panel Finish: Chrome plated or stainless steel.
9. 1.28 gal. per flush.

2.4 TOILET SEATS

A. Toilet Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Bemis Manufacturing Company.
      c. Centoco Manufacturing Corporation.
      d. Church Seats.
      e. Kohler Co.
      f. Olsonite Seat Co.
      g. Sanderson Plumbing Products, Inc.
      h. Zurn Industries, LLC; Commercial Brass and Fixtures.
   4. Type: Commercial (heavy duty)
   5. Shape: Elongated rim, open front
   6. Hinge: Self-sustaining, check
   8. Seat Cover: Not required
   9. Color: White

2.5 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, siphon jet
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Kohler Co.
   2. Fixture:
      b. Material: Vitreous china.
c. Type: Siphon jet

d. Strainer or Trapway: Manufacturer’s standard strainer with integral trap.

e. Water Consumption: Water saving.

f. Spud Size and Location: NPS 3/4; top.

g. Outlet Size and Location: NPS 2; back.

h. Color: White.

3. Waste Fitting:
   b. Size: NPS 2.

4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

5. Urinal Mounting Height: Standard or Handicapped/elderly according to ICC A117.1

2.6 URINAL FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Coyne & Delany Co.
      c. Sloan Valve Company.
      d. Zurn Industries, LLC; Commercial Brass and Fixtures.
   4. Features: Include integral check stop and backflow-prevention device.
   5. Material: Brass body with corrosion-resistant components.
   7. Panel Finish: Chrome plated or stainless steel.
   8. Style: Exposed
   9. Consumption: 0.5 gal. per flush.
   10. Minimum Inlet: NPS 3/4

2.7 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory: Vitreous china, wall mounted, with back.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. Kohler Co.
c. Sloan Valve Company.
d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   b. Type: For wall hanging.
   c. Refer to schedule on drawings for additional requirements.
   d. Faucet-Hole Location: Top.
   e. Color: White.
   f. Mounting Material: Chair carrier.


4. Lavatory Mounting Height: Standard or Handicapped/elderly according to ICC A117.1.

2.8 SOLID-BRASS, MANUALLY OPERATED FAUCETS

A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Manual-type, commercial, solid-brass valve.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Bradley Corporation.
      c. Chicago Faucets.
      d. Delta Faucet Company.
      e. Elkay Manufacturing Co.
      f. Just Manufacturing.
      g. Kohler Co.
      h. Moen Incorporated.
      i. Speakman Company.
      j. T & S Brass and Bronze Works, Inc.
      k. Zurn Industries, LLC; Commercial Brass and Fixtures.
   3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
   5. Finish: Polished chrome plate.
6. Refer to schedule on drawings for additional requirements.
8. Drain: Not part of faucet.

2.9 SERVICE SINKS

A. Service Sinks: Enameled, cast iron, floor mounted.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Kohler Co.
      c. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   b. Style: With front apron and raised back.
   c. Nominal Size: 28 by 28 inches.
   e. Drain: Grid with NFPS 3 outlet.
   f. Rim Guard: Coated wire.

2.10 COUNTER SINKS

A. Sinks: Stainless steel, lay-in counter mounted.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.
      b. Just Manufacturing.

2. Fixture:
   b. Type: Lay-in.
   c. Refer to schedule on drawings for additional requirements.
   d. Metal Thickness: 0.050 inch.
   e. Compartment:
      1) Drain: Grid with NPS 1-1/2 tailpiece and twist drain.
      2) Drain Location: Centered in compartment.
   f. Faucet(s):
      a. Number Required: One.
b. Mounting: Deck.

4. Supply Fittings:
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      1) Operation: Loose key.
      2) Risers: NPS 1/2.

5. Waste Fittings:
   b. Trap(s):
      1) Size: NPS 1-1/2.


2.11 SINK FAUCETS

A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type, mixing valve.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) American Standard America.
      2) Bradley Corporation.
      3) Chicago Faucets.
      4) Delta Faucet Company.
      5) Elkay Manufacturing Co.
      6) Just Manufacturing.
      7) Kohler Co.
      8) Moen Incorporated.
      9) Sloan Valve Company.
      10) Speakman Company.
      11) T & S Brass and Bronze Works, Inc.
      12) Zurn Industries, LLC; Commercial Brass and Fixtures.


3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

5. Finish: Polished chrome plate.
6. Maximum Flow Rate: 2.2 gpm.
7. Refer to schedule on drawing for additional requirements.
8. Mounting Type: Deck.

2.12 SUPPLY FITTINGS
A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
B. Standard: ASME A112.18.1/CSA B125.1.
C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
E. Operation: Loose key.
F. Risers:
   1. Refer to fixture schedule for sizes.
   2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.13 WASTE FITTINGS
A. Standard: ASME A112.18.2/CSA B125.2.
B. Lavatory:
   1. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
   2. Trap:
      a. Size: NPS 1-1/2 by NPS 1-1/4 unless otherwise scheduled.
      b. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch thick brass tube to wall; and chrome-plated, brass or steel wall flange.
C. Sink:
   1. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
   2. Trap:
      a. Size: NPS 1-1/2 unless otherwise scheduled.
      b. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch thick brass tube to wall; and chrome-plated brass or steel wall flange.
2.14 SUPPORTS

A. Water Closet Carrier:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Zurn Industries, LLC.
   2. Standard: ASME A112.6.1M.
   3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Type I Urinal Carrier:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Josam Company.
      c. MIFAB, Inc.
      d. Wade Drains.
      e. Watts; a Watts Water Technologies company.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.6.1M.

C. Type II Lavatory Carrier:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Josam Company.
      c. MIFAB, Inc.
      d. Wade Drains.
      e. Watts; a Watts Water Technologies company.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.6.1M.

2.15 GROUT

A. Refer to Division 20 Section 20 05 00 “Common Work Results” for requirements.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine counters, walls, and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:
   1. Install level and plumb according to roughing-in drawings.
   2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
   3. Support Installation:
      a. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
      b. Use carrier supports with waste-fitting assembly and seal.
      c. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
   4. Flushometer-Valve Installation:
      a. Install flushometer-valve, water-supply fitting on each supply to each water closet.
      b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
      c. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
   5. Install toilet seats on water closets.
   6. Wall Flange and Escutcheon Installation:
      a. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
      b. Install deep-pattern escutcheons if required to conceal protruding fittings.
      c. Comply with escutcheon requirements specified in Division 20 "Common Work Results."
   7. Joint Sealing:
      a. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
      b. Match sealant color to water-closet color.
      c. Comply with sealant requirements specified in Division 07 "Joint Sealants."

B. Urinal Installation:
1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
4. Support Installation:
   a. Install supports, affixed to building substrate, for wall-hung urinals.
   b. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
5. Flushometer-Valve Installation:
   a. Install flushometer-valve water-supply fitting on each supply to each urinal.
   b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   c. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
   d. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
6. Wall Flange and Escutcheon Installation:
   a. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
   b. Install deep-pattern escutcheons if required to conceal protruding fittings.
   c. Comply with escutcheon requirements specified in Division 20 "Common Work Results."
7. Joint Sealing:
   a. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   b. Match sealant color to urinal color.
   c. Comply with sealant requirements specified in Division 07 "Joint Sealants."

C. Lavatory Installation:
1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 20 "Common Work Results."
5. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 "Joint Sealants."
6. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Division 20 "Mechanical Insulation."

D. Sink Installation:
1. Install sinks level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-hung sinks.
3. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
4. Set floor-mounted sinks in leveling bed of cement grout.
5. Install water-supply piping with stop on each supply to each sink faucet.
   a. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Division 20 "General-Duty Valves for Piping."
   b. Install stops in locations where they can be easily reached for operation.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 20 "Common Work Results."
7. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Division 20 "Mechanical Insulation."

3.3 CONNECTIONS
A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Division 22 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Division 22 "Sanitary Waste and Vent Piping."
D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

3.4 ADJUSTING
A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Adjust water pressure at faucets, flushometer valves, shower heads, etc. to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION
A. After completing installation of fixtures, inspect and repair damaged finishes.
B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16
SECTION 23 01 30 – EXISTING HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Division 20 Section 20 05 00 “Common Work Results for Mechanical” requirements apply to this section.
   C. Division 01 Section 01 31 00 “Project Management and Coordination” applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
   D. Division 01 Section 01 91 13 “General Commissioning Requirements” applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
   A. Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.
   B. Related Requirements:
      1. Division 20 Section 20 05 93 "Testing, Adjusting, Balancing for HVAC" for system flow documentation before cleaning and balancing and following cleaning and restoration.
      2. Division 23 Section 23 31 13 "Metal Ducts" for cleaning newly installed metal ducts.
      3. Division 23 Section 23 33 00 "Air Duct Accessories" for restoration of opened ducts and plenums with access doors.

1.3 DEFINITIONS
   A. ACAC: American Council for Accredited Certification.
   B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program
   C. ASCS: Air systems cleaning specialist.
   E. CMI: Certified Microbial Investigator.
   F. CMC: Certified Microbial Consultant.
   G. CMR: Certified Microbial Remediator.
H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.


1.4 ACTION SUBMITTALS

A. Product Data:
   1. Cleaning agents
   2. Antimicrobial surface treatments
   3. Adhesives and sealants

B. Sustainable Design Submittals:
   1. Product Data: For adhesives and sealants, indicating VOC content.
   2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. For an ASCS.
   2. For an IEP.
   3. For a CMR and a CMRS.

B. Field Quality-Control Reports:
   1. Project's existing conditions.
   2. Evaluations and recommendations, including cleanliness verification.

1.6 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.7 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.
   1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
2. Supervisor Qualifications: Certified as an ASCS by NADCA.

B. IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.

C. IEP Qualifications: CMC who is certified by ACAC and accredited by CESB.

D. CMR Qualifications: Certified by ACAC and accredited by CESB.

E. CMRS Qualifications: Certified by ACAC and accredited by CESB.

F. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

G. Cleaning Conference: Conduct conference at Project site.
   1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Apex Engineering Products Corporation.
   2. BBJ Environmental Solutions.
   5. QuestVapco Corporation.

B. Description:
   1. Formulated for each specific soiled coil condition that needs remedy.
   2. Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Contec, Inc.
   3. Ecolab, Inc.

B. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.
   1. Formulated to kill and inhibit growth of microorganisms.
2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
3. Have no residual action after drying, with zero VOC off-gassing.
4. OSHA compliant.
5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.

C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:
   1. Supervisor contact information.
   2. Work schedule, including location, times, and impact on occupied areas.
   3. Methods and materials planned for each HVAC component type.
   4. Required support from other trades.
   5. Equipment and material storage requirements.
   6. Exhaust equipment setup locations.

D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.
   1. Prepare written report listing conditions detrimental to performance of the Work.

E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.
3.2 CLEANING

A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.

E. Systems and Components to Be Cleaned: See keynoted areas on plans.

F. Types of systems and Components to Be Cleaned:
   1. Air devices for supply and return air.
   2. Ductwork:
      a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
      b. Return-air ducts to the air-handling unit.
      c. Exhaust-air ducts.
      d. Transfer ducts.
   3. Air-Handling Units:
      a. Interior surfaces of the unit casing.
      b. Coil surfaces compartment.
      c. Condensate drain pans.
      d. Fans, fan blades, and fan housings.
      e. Manual and motorized dampers
   4. Filters and filter housings.

G. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

H. Particulate Collection:
   1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
   2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

I. Control odors and mist vapors during the cleaning and restoration process.

J. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
K. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

L. Clean all air-distribution devices, registers, grilles, and diffusers.

M. Clean non-adhered substance deposits according to NADCA ACR and the following:
   1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
   2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
   3. Clean evaporator coils, reheat coils, and other airstream components.

N. Air-Distribution Systems:
   1. Create service openings in the HVAC system as necessary to accommodate cleaning.
   2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

O. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

P. Mechanical Cleaning Methodology:
   1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
      a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
      b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.
   2. Cleaning Mineral-Fiber Insulation Components:
      a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
      b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
      c. Fibrous materials that become wet shall be discarded and replaced.

Q. Coil Cleaning:
1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.

2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.

3. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.

4. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.

5. Rinse thoroughly with clean water to remove any latent residues.

R. Application of Antimicrobial Treatment:

1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.

2. Apply antimicrobial treatments and coatings after the system is rendered clean.

3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.

4. Microbial remediation shall be performed by a qualified CMR and CMRS.

3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Verification of Coil Cleaning:

1. Measure static-pressure differential across each coil.

2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of the differential when the coil was first installed.

E. Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

G. Prepare a written cleanliness verification report. At a minimum, include the following:
   1. Written documentation of the success of the cleaning.
   2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
   3. Surface comparison test results if required.
   4. Gravimetric analysis (nonporous surfaces only).
   5. System areas found to be damaged.

H. Photographic Documentation: Comply with requirements in Division 01 "Photographic Documentation."

3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Division 23 "Metal Ducts."

C. Replace damaged insulation according to Division 20 "Mechanical Insulation."

D. Ensure that closures do not hinder or alter airflow.

E. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

F. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

G. Measure air flows through air-distribution system.

H. Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

A. Post-Project Report:
   1. Post-cleaning laboratory results if any.
   2. Post-cleaning photo images.
   3. Post-cleaning verification summary.

B. Drawings:
   1. Deviations of existing system from Owner's record drawings.
   2. Location of service openings.
EXISTING HVAC AIR-DISTRIBUTION SYSTEM CLEANING
SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

E. Division 26 Section 26 05 00 “Common Work Results for Electrical” requirements apply to this section and requires contractor participation in the Above Ceiling Coordination Program.

1.2 DEFINITIONS

A. BAS: Building Automation System

B. DDC: Direct Digital Control

C. EMS: Energy Management System consisting of BAS (typically with a PC and support software), DDC controllers, and networking software/hardware/wiring.

D. I/O: Input/output

E. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks licensed by Echelon Corp.

F. BACnet: A communications protocol for implementing interoperable controllers established by ASHRAE

G. MS/TP: Master-slave/token-passing network for BACnet

H. PC: Personal computer

I. PID: Proportional plus integral plus derivative

1.3 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The Systems Integrator (SI) contractor, under separate contract will provide PC-based programming
workstations. Microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions will be provided by the BAS contractor.

B. For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The SI Systems Integrator supplier shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.

2. Web-Based Operator Workstations: The SI Systems Integrator supplier shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.

3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS system supplier shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).

4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

C. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTPS for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

D. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
E. The system shall enable an open architecture that utilizes BACnet functionality to assure interoperability between all system components. Native support for BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

F. The AAC shall be capable of communicating as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

G. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.

H. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives and power metering should easily coexist on the same network channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

I. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 5 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in-place support facility within 120 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

1.4 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1. Provide Building Automation System (BAS) as shown in the contract documents and described herein.
2. Provide interface to BAS via BACnet as shown in the contract documents and described herein.
3. Provide DDC System as shown in the contract documents and described herein.
4. Sequences modified as a result of start-up, checkout, fine tuning, and/or commissioning shall be resubmitted to the Architect for record.

5. Systems integration: The installing contractor is responsible for and shall provide the integration of the DDC with the existing EMS, including (but not limited to):
   a. Insuring that the new DDC Controllers shall interface to the existing EMS network. There are three levels of system architecture: a campus-wide Management Level Network (MLN) that is Ethernet based IP protocol, a high performance peer-to-peer Building Level Network (BLN), and an Application Specific Controller Floor Level Network (FLN). Access to all levels from the EMS appears transparent to the user when accessing data graphically or developing control programs.
   b. The design of the new installation shall allow the existing controllers to co-exist with the newly installed controllers without the use of gateways or protocol convertors.
   c. New DDC Controllers shall be fully and readily accessible from existing graphical user workstations.
   d. Providing communication wiring (cable) from the newly installed DDC controllers to the nearest existing controller or networked to the Owner's IT network drop.
   e. If required for networking, a network interface controller including hardware and panel, software (or firmware), and coordinating electrical power (and UPS back-up if required by Owner) per the contract documents.
   f. Providing expansion of and/or upgrading of any network panel software/firmware and/or memory size to accommodate the additional point database and communication traffic (bandwidth) caused by accessing information across the network from the Owner's EMS for graphical display purposes. Inclusive with this is necessary memory or bandwidth for trend data collection.
   g. Coordination with the Owner's IT group in terms of their providing for the additional bandwidth requirements as a result of the installation.
   h. If not currently at the latest software release version, providing the latest EMS software upgrade to bring the system to the most current released version.

B. Related Sections include the following:
1. Division 23 Section 20 05 19 "Meters and Gages" for measuring equipment that relates to this Section.
2. Division 26 Section 26 09 36 "Lighting Controls" for requirements that relate to this Section.

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
1. Graphic Display: Display graphic with minimum 30 dynamic points with current data within 5 seconds.
2. Graphic Refresh: Update graphic with minimum 30 dynamic points with current data within 2 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 15 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   1) Water Temperature: Plus or minus 1-degree F.
   2) Water Flow: Plus or minus 5 percent of full scale.
   3) Water Pressure: Plus or minus 2 percent of full scale.
   4) Space Temperature: Plus or minus 1-degree F.
   5) Ducted Air Temperature: Plus or minus 1-degree F.
   6) Outside Air Temperature: Plus or minus 2-degrees F.
   7) Averaging Air Temperature: Plus or minus 2-degrees F.
   8) Dew Point Temperature: Plus or minus 2-degrees F.
   9) Temperature Differential: Plus or minus 0.27-degrees F.
  10) Relative Humidity: Plus or minus 5-percent relative humidity (% RH).
  11) Airflow (Pressurized Spaces): Plus or minus 2-percent of full scale (% FS).
  12) Airflow (Measuring Stations): Plus or minus 3-% FS.
  13) Airflow (Terminal): Plus or minus 5-% FS.
  14) Air Pressure (Space): Plus or minus 0.0005-inches wg.
  15) Air Pressure (Ducts): Plus or minus 0.02-inches wg.
  16) Carbon Monoxide: Plus or minus 1-part per million (ppm) CO.
  17) Carbon Dioxide: Plus or minus 50-ppm CO2.
  18) Electrical: Plus or minus 2-percent of reading (volts/amps/watts).

1.6 SEQUENCE OF OPERATION

A. Sequences of Operation are included on the temperature control drawings (plans).

1.7 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Building Automation System: Include technical data for operator workstation, operating system software, color graphics; editors for graphics, point database, and programming; software licensing, software updates during construction, and other third-party applications.
2. **DDC System Hardware**: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for remote operator's terminal, operator display menus, interface equipment to BAS, DDC Controllers, Unitary Controllers, Application Specific Controllers (e.g. Air Terminal Controller), transducers/transmitters, sensors, control dampers, damper actuators, control valves, valve actuators, relays-switches, auxiliary control panels.

3. **Controlled Systems**: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

**B. Shop Drawings**: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. **Wiring Diagrams**: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
   a. Coordinate dampers sizes with sheet metal and/or mechanical contractor before submitting.
7. Schedule of valves including flow characteristics.
8. Schedule of Terminal Equipment Controllers; e.g. air terminals, unit ventilators, etc.
9. **DDC System Hardware**:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
10. **Control System Software**: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
11. **Controlled Systems**:
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   c. Written description of sequence of operation including schematic diagram.
   d. Points list.

**C. Data Communications Protocol Certificates**: Certify that each proposed DDC system component complies with ASHRAE 135.
D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

F. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals
   2. Program Software Backup: On a DVD (CD-ROM) complete with data files provided on quarterly or monthly basis throughout construction as determined at the start of construction as mutually agreed by the construction manager, commissioning authority, owner’s representative, and the programming contractor.
   3. Device address list
   4. Printout of software application and graphic screens
   5. Software licenses required by and installed for DDC workstations and control systems

G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

H. Field quality control test reports

I. Installing contractor’s commissioning reports

J. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance instructions and list of spare parts for each type of control device and the compressed air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   4. Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
   5. Calibration records and list of set points.

1.8 QUALITY ASSURANCE

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.
   1. The Building Management System contractor shall have a full service facility within 120 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor’s technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
   2. Any installing contractor, not listed as prequalified in the Approved Manufacturer’s section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer’s
3. The following contractors have been pre-qualified for programming:
   a. Johnson Controls – Metasys only
   b. Wadsworth

B. All bidders must be authorized distributors or branch offices of the manufacturers specified.

C. The following bidders have been pre-qualified for installation:
   1. Schneider Electric
   2. Johnson Controls – Metasys only
   3. Trane
   4. W.J. O’Neil

D. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

E. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the Owner and Architect’s representatives. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.

F. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

G. Required elements of the startup testing include:
   1. Measurement of voltage sources, primary and secondary
   2. Verification of proper controller power wiring.
   3. Verification of component inventory when compared to the submittals.
   4. Verification of labeling on components and wiring.
   5. Verification of connection integrity and quality (loose strands and tight connections).
   7. Verification of point checkout.
   8. Each I/O device is landed per the submittals and functions per the sequence of control.
   9. Analog sensors are properly scaled and a value is reported
   10. Binary sensors have the correct normal position and the state is correctly reported.
   11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.

13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).

14. Documentation of Loop tuning (sample rate, gain and integral time constant).

H. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.

1. Graphics navigation. (SI Validation)
2. Trend data collection and presentation. (SI Validation)
3. Alarm handling, acknowledgement and routing. (SI Validation)
4. Time schedule editing. (SI Validation)
5. Application parameter adjustment. (SI Validation)
7. Report execution. (SI Validation)
8. Automatic backups. (SI Validation)
9. Web Client access. (SI Validation)

I. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, DDC control sensors, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

F. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
G. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

H. Coordinate installation of control dampers, smoke dampers, HVAC equipment isolation dampers, and pipe-mounted sensors and instruments with the mechanical and/or plumbing contractor.

I. Coordinate installation of duct, space, outdoor, or building static pressure sensors with the finished surfaces, installing contractor and the Architect prior to installation.

J. Coordinate installation of any exterior wall or roof-mounted sensors, instruments, photocells, or controllers required for the temperature control system with the General Contractor and the Architect prior to installation.

K. Coordinate the color selection process of any sensor or device intended to be mounted on finished surfaces with the Architect prior to installation.

1.11 OWNERSHIP

A. The Owner shall retain licenses to software for this project.

B. The Owner shall sign a copy of the manufacturer’s standard software and firmware licensing agreement as a condition of this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer’s license agreement, but shall protect the manufacturer’s rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner’s computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
   1. Server and workstation software
   2. Application programming tools
   3. Configuration tools
   4. Network diagnostic tools
   5. Addressing tools
   6. Application files
   7. Configuration files
   8. Graphic files
   9. Report files
   10. Graphic symbol libraries
   11. All documentation

1.12 WORK BY OTHERS

A. The BAS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others’ work.
The BAS system supplier shall coordinate all installation, devices, and programming with the system integrator for a complete and operational system compliant to the functionality depicted and described in the construction documents.

B. The BAS system supplier shall furnish all Flow Meters for installation by the Mechanical Contractor and/or others.

C. The BAS system supplier shall provide field supervision to the designated contractor for the installation of the following:
   1. Automatic control dampers
   2. Blank-off plates for dampers that are smaller than duct size.
   3. Sheet metal baffles plates to eliminate stratification.
   4. The Electrical Contractor shall provide:
      a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels.
      b. Furnish smoke detectors and wire to the building fire alarm system. EC to hardwire to fan shut down.

D. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

E. Deliver materials to the Project site in supplier’s or manufacturer’s original wrappings and containers, labeled with supplier’s or manufacturer’s name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

F. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.13 WARRANTY

A. The control system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the control system. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.

B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).

C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.
D. This system shall be inspected by the control system Contractor for a four-hour period once each quarter during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.

E. The control system Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved and work accomplished.

F. Owner shall be able to make changes to database, when prior database is stored on disk in case of error in change, without affecting or voiding warranty.

1.14 MAINTENANCE

A. The control system Contractor shall provide and maintain on site working spare parts for the control system during the warranty period including DDC Controllers, power supplies, modules, sensors, floor level (subnet) devices, transformers, etc. The owner will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The control contractor Contractor shall refurbish/replace spare parts in exchange for failed items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Product: Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
   1. Electric Components
      a. Schneider-Electric / Johnson Controls / Trane Field Devices
   2. Electronic Components
      a. Schneider-Electric/ Johnson Controls / Trane Field Devices
   3. Direct Digital Control Systems Field Controller Devices:
      a. Schneider Electric / Johnson Controls / Trane

2.2 OPEN, INTEROPERABLE SYSTEM ARCHITECTURE

A. General
   1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs) and a family of Standalone Digital Control Units (SDCUs). Administration and Programming Workstations (APWs) and Web-based Operator Workstations (WOWs) are provided by SI. Alarm notifications, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable will be provided by SI. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
   2. An Enterprise Level BAS provided by SI shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming,
and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.

3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.

4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.

5. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.

6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. The fieldbus layer shall support all of the following types of SDCUs:
1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller.
2. BACnet MS/TP SDCU requirements: (Only where shown on the control architecture drawings)
   The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 38.4 kbps. The field bus layer consists of an RS485, token passing bus that supports Standalone Digital Control Units (SDCUs) for operation of HVAC. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses per NSC.

F. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC’s, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems Department as all devices utilize standard TCP/IP components. All added BAS supplied switches and routers must be approved by owner’s Information Systems Department.

H. System Expansion
1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.

2. Web-based operation shall be supported directly by the NSCs and require no additional software.

3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.

I. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS: (N4 SUPERVISOR AND WORKSTATION SOFTWARE PROVIDED BY SYSTEM INTEGRATOR) (VENDOR SPECIFIC PROGRAMMING TOOLS OR N4 JAR FILES PROVIDED BY BAS CONTRACTOR)

A. A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 3 concurrent client licenses at the enterprise level. Client licenses are licenses that can be used for variable designations of the users choosing; i.e. operator, engineering, or web capabilities.

2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.

3. At the NSC level, there shall be no cap on concurrent web-based workstations (webstations) other than what the CPU capacity can support.

4. All configuration workstations shall be desktop personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.

5. A minimum of 1 physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. N4 Supervisor, Administration/Programming Workstation, and Webstation requirements

1. The N4 Supervisor shall consist of the following:
   a. Processor
      1) Minimum: Intel Xeon CPU E5-2640 x64 (or better) compatible with dual and quad core processors
   b. Memory
1) 64GB or higher recommended

   Operating systems:
   1) Microsoft Windows 10 64-bit
   2) Microsoft Windows 11 64-bit
   3) Microsoft Windows Server 2016
   4) Microsoft Windows Server 2019

d. 10/100MBPS Ethernet NIC

e. Storage
   1) Minimum: 1TB or higher
   2) Solid State Drive recommended

   Required additional software:
   1) Microsoft .Net 4.7.2 and later

g. License agreement for all applicable software

2. The Workstation shall consist of the following:

   a. Processor
      1) Minimum: Intel Core i5 @ 2.0 GHz or equivalent
      2) Recommended: Intel Core i5 @ 3.0 GHz or better

   b. Memory
      1) Minimum: 8GB or higher

   c. Operating systems:
      1) Microsoft Windows 10 64-bit
      2) Microsoft Windows 11 64-bit
      3) Microsoft Windows Server 2016
      4) Microsoft Windows Server 2019

   d. 10/100MBPS Ethernet NIC

   e. Storage
      1) Minimum: 20GB
      2) Recommended: 1TB
      3) Solid State Drive recommended

   f. Required additional software:
      1) Microsoft .Net 4.7.2 and later

   g. License agreement for all applicable software

3. Web-Based Operator PC Requirements

   a. Any user on the network can access the system, using the following software:

   b. Minimum:
      1) Google Chrome 61 or higher
      2) Mozilla Firefox 60 or higher
      3) Microsoft Edge (EdgeHTML) 16 or higher
      4) Safari 11.1 or higher

   c. Recommended:
      1) Google Chrome 71 or higher
      2) Mozilla Firefox 64 or higher
      3) Microsoft Edge (EdgeHTML) 17 or higher
      4) Safari 11.4 or higher
C. General Administration and Programming Workstation Software (Workstation software provided by System Integrator) (Vendor specific programming tools or N4 jar files provided by BAS Contractor)

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.

2. The workstation functions shall include monitoring and programming of all DDC controllers. All field level controllers must have the ability to be programmed from the N4 workstation software.

3. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

4. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

D. User Interface: (Provided by System Integrator)

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.

3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.

4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.

5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.

6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.

7. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.

8. Workstation shall indicate at all times the communication status between it and the server.

9. The BMS web interface shall enable presentation mode whereby any functionality for interactivity shall be disabled.
10. The BMS web interface shall automatically detect light mode and dark mode settings in the operating system and adapt accordingly.
11. The BMS web interface shall allow override of the operating systems light/dark mode settings so that the setting can be enabled independent of the operating system’s setting.
12. The BMS web interface shall automatically respond and adapt to different screen sizes and orientations from smart phone to smart televisions of any size.
13. The BMS web interface shall support slideshow functionality.
14. The BMS web interface shall support full screen mode displaying Alarm views / graphics / dashboards / Custom Reports.

E. User Access and Permissions (Provided by System Integrator)
1. The BMS system shall allow for creation of one account per user.
2. The BMS shall support Groups where User Accounts associated with the group can inherit group permissions.
3. The BMS shall be able to specify each user account / group accessibility to each object in the system.
4. The BMS permission system shall be possible to integrate with Windows Active directory.
5. The BMS shall be able to report on the permission level across account / group for review / archiving / audit.
6. This username/password combination shall be linked to a set of capabilities within the software, set and editable only by user with system administrator privileges. The sets of capabilities shall include: edit or View only, Acknowledge alarms, Enable/disable Program and change values.
7. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.
8. The BMS shall support integration with Windows Active Directory for user log on credentials.
9. The BMS shall support configurable reminder for “Days until password expires”.
10. The BMS shall support configurable password policy across:
   a. Minimum number of characters
   b. Minimum number of lowercase characters
   c. Minimum number of numeric characters
   d. Minimum number of special characters
   e. Number of consecutive unique passwords before reuse
   f. No more than three repeating identical characters
11. The BMS user account management shall support password policy with the following components:
   a. Mandatory change of password at first logon with default credentials
   b. Disabling of all imported user accounts by default
   c. Custom password complexity rules and its enforcement
   d. Custom password reuse and its enforcement
   e. Configurable black listing of passwords to limit the use of common known passwords (e.g. password)
   f. Password aging rules
12. The BMS shall be capable of enabling an anonymous access (guest account) to previously engineered views such as dashboards, graphics, etc. with configurable permissions and without username or password.

13. It shall be possible to configure the BMS system so that the guest account is used by default to simplify presentation of Kiosk Mode across multiple screens.

14. The BMS shall provide time configurability to logout the user and to revert to a preconfigured presentation view, such as offered by the Guest account functionality.

15. The BMS shall provide configurability in managing access and permission levels based on location, IP addresses and address ranges, Schedule and Time of day and combination thereof.

F. System Security

1. The BMS system supplier shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.

2. The BMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.

3. The BMS shall support configuration for inactivity auto log-off of logged clients.

4. The BMS system shall support Self-Signed Certificates, Default Certificates and/or Certification Authority (CA) certificates.

5. The BMS client communications (web access or rich client access) shall support TLS 1.2 encryption or higher.

6. The BMS shall allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.

7. The BMS must be able to Alarm or generate notification on failed access attempts.

8. The BMS Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks.

9. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.

10. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

11. The BMS shall have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access.

12. The BMS shall have the capability to differentiate, limit or enable, user access depending on Client’s IP address/range (where) and time of day (when) the user is accessing the system.

G. Configuration Interface: (Workstation software provided by System Integrator) (Vendor Specific Jar files provided by BAS Contractor)

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an
easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays (Provided by System Integrator)

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. The system shall support HTML5 enabled graphics.
   c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
   d. The editor shall use Scalable Vector Graphics (SVG) technology.
   e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
   f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
   g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
   h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
   i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
   j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
   k. Graphics should rescale based on whatever monitor or viewing device is being used.
   l. Be able to create graphics on varying layers that can be moved and repeated.
   m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
   n. The ability to create re-usable cascading menus.
The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
   a. Create and save pages.
   b. Group and ungroup symbols.
   c. Modify an existing symbol.
   d. Modify an existing graphic page.
   e. Rotate and mirror a symbol.
   f. Place a symbol on a page.
   g. Place analog dynamic data in decimal format on a page.
   h. Place binary dynamic data using state descriptors on a page.
   i. Create motion through the use of animated .gif files or JavaScript.
   j. Place test mode indication on a page.
   k. Place manual mode indication on a page.
   l. Place links using a fixed symbol or flyover on a page.
   m. Links to other graphics.
   n. Links to web sites.
   o. Links to notes.
   p. Links to time schedules.
   q. Links to any .exe file on the operator work station.
   r. Links to .doc files.
   s. Assign a background color.
   t. Assign a foreground color.
   u. Place alarm indicators on a page.
   v. Change symbol/text/value color as a function of an analog variable.
   w. Change a symbol/text/value color as a function of a binary state.
   x. Change symbol/text/value as a function of a binary state.

I. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management (Provided by System Integrator)
   1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
   2. Alarm management features shall include:
      a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels.
      b. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
      c. At the N4 Supervisor level the minimum number of active and viewable alarms shall be 10,000.
d. It shall be possible for the user to sort, filter and search on any available criteria such as priority, category, origin, alarm type, etc.
e. An active alarm viewer shall be included which can be customized for each user or user type to a hide or display any alarm attributes.
f. It shall be possible to present alarms with configurable colors based on priority, category, origin, alarm type, etc.
g. It shall be possible to linking files/documents/hyperlinks/navigation links/graphics link to an alarm for easy access upon occurrence
h. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
i. Alarm notifications must support multiple distribution methods within one notification
j. On alarm, it shall be possible to notify via email to a preconfigured list of recipients through a Simple Mail Transfer Protocol (SMTP) or secure email using Simple Mail Transfer Protocol Secure (SMTPS). No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
k. On alarm, it shall be possible to notify via SNMP
l. On alarm, it shall be possible to notify via file (on disk) that would be consumable by other alarm management services
m. An operator shall have the capability to assign an alarm to another user of the system.
n. Individual alarms shall be able to be assigned to a user automatically via a preconfigured list of users and date/time. For example, a critical high temp alarm can be configured to be assigned to a Facilities Dept or to a Central Alarming workstation depending on time/date.
o. Playing an audible sound on alarm initiation or return to normal.
p. It shall be possible assigning a custom audio sound to each alarm / alarm-criteria (priority, category, origin, alarm type, etc.)
q. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
r. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
s. The alarm viewer can be configured to auto hide alarms when triggered.
t. An operator shall have the capability to save and apply alarm favorites.
u. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
v. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
w. It shall be possible to configure user-actions via user/group permissions when responding to an alarm
x. All operator actions responding to an alarm must be audit trailed.

K. Static Paginated Reporting / Custom Reporting (Provided by System Integrator)
1. The BMS Software and Network Servers shall support built-in native reporting capability without dependency on any external software.

2. It shall be possible to generate custom reports manually, via Schedule, Alarm triggered or custom conditions (e.g. program/schedule/etc.).

3. The Custom Reporting shall have no dependency on external database.

4. The Custom Reporting shall have the capability of reporting on the full range of available data, most recent to historical data.

5. It shall be possible to generate reports containing current active alarms.

6. The Building Management System software shall natively be capable of producing custom reports in txt, xls, and pdf file formats.

7. The Custom Report capability at the BMS software shall support digital signing of pdf for traceability and authenticity.

L. Scheduling (Provided by System Integrator)

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.

2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.

3. Schedules shall be programmable for a minimum of one year in advance.

4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.

5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.

8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.

9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.

10. It should accommodate a minimum of 16 priority levels.

11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer’s Environment (Workstation software provided by System Integrator) (Vendor Specific Jar files provided by BAS Contractor)

1. Programming in the NSC shall be in graphical block format.

2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.

3. The programmer’s environment will include access to a superset of the same programming language supported in the SDCUs.

4. NSC devices will support a graphical function block programming language.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.

6. It shall be possible to view graphical programming live and real-time from the Workstation.

7. Key terms should appear when typing (IntelliType).

8. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.

9. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading (Workstation software provided by System Integrator) (Vendor Specific Jar files provided by BAS Contractor)
   1. The workstation software shall have an application to save and restore NSC and field controller memory files.
   2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
   1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
   2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
   3. The N4 Supervisor shall be able to store up to 5 million events.
   4. The event view shall support viewing of up to 100,000 events.
   5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
   6. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant N4 Supervisor Operation (Top level NSC)
   1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software (Provided by System Integrator)
   1. General:
      a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
      b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
      c. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
   2. Graphic Displays
a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser’s graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.

b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.

c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on login credentials.

d. The user shall have the ability to create custom dashboards.

e. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.

3. Alarm Management

a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.

b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user’s password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules

1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail

1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

T. All commands and user activity through the browser interface shall be recorded in the system’s activity log, which can be later searched and retrieved by user, date, or both.

2.4 NETWORK SERVER CONTROLLERS (NSC: ALSO KNOWN AS JACE-8000)

A. Network Server Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization by means of an Internet site including automatic synchronization
   6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
   7. Network Management functions for all LonWorks based devices

L. Hardware Specifications
   1. Memory:
      a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
   2. Each JACE-8000 shall provide the following on-board hardware for communication:
      a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
         1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
         2) Support IPv4 addressing
         3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
         4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
5) It shall be possible to disable Ethernet port 2
6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
7) Where a switch is needed, use an approved model from owner’s information technology dept.

b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
c. One device USB port
d. One host USB port

3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

M. Modular Expandability:
1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system online without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:
1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures
1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
   a. 10 kohm Type I
   b. 10 kohm Type II
   c. 10 kohm Type III
   d. 10 kohm Type IV
   e. Linearized 10 kohm Type V (FD w/11k shunt)
   f. Linearized 10 kohm
   g. 1.8 kohm
   h. 1 kohm
   i. 20 kohm
   j. 2.2 kohm
2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
   a. PT100
b. PT1000  
c. Ni1000

P. Local Status Indicator Lamps:
1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):
1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 10 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:
1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:
1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

T. Data Retention:
1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

U. Software Specifications:
1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

V. User Programming Language:
1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source
program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.

2. Network Server Controllers that use a "canned" program method will not be accepted.

W. Control Software:
1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

X. Mathematical Functions:
1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

Y. NSCs shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

Z. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be
downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.

2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.

3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.

4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.

5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

6. Tooltips shall be present, magnetic, and visible based on users preference.

7. Comments shall be visible whenever viewing the trend log list.

8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

9. The BMS software and Network Servers shall support recording of all historical data, independent of any limitation in its local memory, which will be readily available for reporting and analysis without additional configurations or actions.

10. All historical data shall be available for use by the operator to access in BMS or a third-party reporting systems.

AA. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.

2. There is no limit to the number of alarms that can be created for any point.

3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.

4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.

5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.

6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OFS device profile and uses the BACnet/IP protocol.

BB. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2. The NSC shall be configurable to logging all Embedded Web Server access attempts.
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide the ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

CC. The NSC controller shall comply with the following regulatory certifications
1. CE – EN 61000-6-3
2. CE – EN 61000-6-2
3. CE – EN 61010-1
4. CE – EN 61326-1
5. FCC CFR 47 Part 15 Class A
6. RCM
7. RoHS 2011/65/EU
8. China RoHS SJ/T 11364-2014
9. UL916 Energy Management equipment

DD. HMI
1. The NSC shall have an option for a tablet display
2. The tablet display shall be an industrial grade Human Machine Interface (HMI) that can be locked to the building management application to create a dedicated tool for local operation and maintenance.
3. The tablet display shall provide an easy-to-use interface through which users and engineers can locally access NSC’s
4. The tablet display shall always start in a kiosk mode ensuring the end user can only use the device using the installed integration with the NSC.
5. The tablet display shall always require a password on start up
6. The tablet display shall require a password after a defined period of inactivity
7. The tablet display shall support being handheld or being installed on a control cabinet.
8. The tablet display user interface shall provide touchscreen navigation making it easy to operate and maintain the system.
9. The tablet display shall support robust physical panel mounting mechanisms provided with the product.
10. The tablet display shall have a screen size of 255mm or 10.1 inches
11. The tablet display shall support a screen resolution of 1280 by 800 pixels
12. The tablet display shall have a 16:10 aspect ratio
13. The tablet display shall be based on the Android platform
14. The tablet display shall have an IP54 rated frame that helps protect against dust and moisture.
15. The tablet display shall be powered by a 24 VDC power supply
16. The tablet display can be powered by a 24 VDC through the Y-shaped cable.
17. The tablet display shall be able to communicate with the NSC over a wired (USB) connection running BACnet IP over USB.
18. The tablet display shall have an accessory Wi-Fi Module as an option instead of using USB for communication.
   a. Through the Wi-Fi module, you can establish wireless communication between the tablet display and the NCS connected to a wireless access point.
   b. The Wi-Fi module shall have an adhesive mount Wi-Fi antenna.
   c. The Wi-Fi module shall be compliant with IEEE 802.11 b/g/n.
   d. The Wi-Fi module shall support enhanced wireless security using 64-bit and 128-bit WEP encryption.
19. The tablet display shall connect to the NSC using only secure, HTTPS connections via the WebStation functionality of the NSC.
20. The tablet display shall connect using a specific user and password combination defined as part of the NSC configuration.

2.5 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol
   1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC).
   2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
      a. All controllers shall be able to communicate peer-to-peer without the need for a NSC.
      b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
   1. Supporting IPv4 addressing
   2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
   3. It shall be possible to disable Ethernet port 2.

C. Topologies
   1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
   2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
      a. In case of any disruption there shall be no communication interruption
      b. In case of any disruption there shall be system alarms that will inform the operator of the disruption.
D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.

2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.

2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs.

3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps.

5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.

6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs.

7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output).

8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
   a. Control processes
   b. Energy management applications
   c. Alarm management
   d. Historical/trend data
   e. Maintenance support applications
   f. Custom processes
   g. Manual override monitoring

9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.

10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.

11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.

12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
   a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
      1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
         a) 10 kohm Type I
b) 10 kohm Type II
c) 10 kohm Type III
d) 10 kohm Type IV
e) Linearized 10 kohm Type V (FD w/11k shunt)
f) Linearized 10 kohm
g) 1.8 kohm
h) 1 kohm
i) 20 kohm
j) 2.2 kohm
k) PT100
l) PT1000
m) Ni1000

2) Analog inputs
   a) Current Input - 0-20 mA
   b) Voltage Input 0-10 Vdc

3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.

4) Digital outputs

5) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
   a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
      1) Automatically synchronize system clocks daily from an operator-designated controller.
      2) The system shall automatically adjust for daylight saving time.
   b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
   c. The RTC shall provide the following: time of day, day, month, year, and day of week.
   d. The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.

14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
   a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
   b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
   c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
   d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
   e. All balancing parameters shall be synchronized in NSC

15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection

16. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power

17. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
   a. CE - EMCD 2014/30/EU
b. CE LVD 2014/35/EU

c. FCC CFR 47 Part 15 Class B

d. RCM

e. RoHS 2011/65/EU

f. China RoHS SJ/T 11364-2014

g. UL2043 (Plenum space mounting)
h. UL916 Open-Energy Management equipment
i. UL916 Energy Management equipment

18. Intelligent Space Sensor Interface –

b. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs

b. It shall be possible to disable the RJ45 communication port.

19. The BACnet/IP Fieldbus controller for Connected Room solutions

a. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v14 or later) as specified BACnet Advanced Application Controller (B-AAC)

b. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
   1) All controllers shall be able to communicate peer-to-peer without the need for an NSC
   2) Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

c. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
   1) Supporting IPv4 addressing
   2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
   3) It shall be possible to disable Ethernet port 2
   4) Each BACnet/IP controller shall be configurable to restrict communications to only whitelisted IP addresses.

d. Topologies
   1) BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
   2) BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
      a) In case of any disruption there shall be no communication interruption
      b) In case of any disruption there shall be system alarms that will inform the operator of the disruption

e. Performance
1) Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2012 and the BACnet Device Profile supported.

2) They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

3) Each BACnet/IP Fieldbus Controllers shall support upgrade of its firmware with no impact to its operation

f. Programmability

1) The BACnet/IP Fieldbus controllers shall support graphical programming that will be consistent with the NSC.

2) The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs

3) All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

4) The BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps

5) The BACnet/IP Fieldbus controllers shall support two RS485 communication ports for connecting and supplying power to a range of protocol types

   a) BACnet/IP Fieldbus controllers shall support configurable selection of the supported protocol on the RS485 communications ports,

   b) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.

   c) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching connected module for the purpose of control of lights and blinds that do not utilize any of the I/O points of the controller

   d) BACnet/IP Fieldbus controllers shall support a communications capability for connecting to open market Modbus devices

   g. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:

   1) Control processes

   2) Energy management applications

   3) Alarm management

   4) Historical/trend data

   5) Maintenance support applications

   6) Custom processes

   h. In the case of communication disruption between the BACnet/IP Fieldbus controller and NSC/BMS, each BACnet/IP Fieldbus controller shall support storage of local trend data up to 2x the number of its built-in I/O at the collection rate of 5 min for 5 days.
i. The BACnet/IP Fieldbus controller analog or universal input shall use a 16-bit A/D converter.

j. The BACnet/IP Fieldbus controller analog or universal output shall use a 10-bit D/A converter.

k. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
   1) Up to 8 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
      a) Universal Inputs – the following thermistors for use in the system without any external converters needed.
      b) 10K Ohm Type I
      c) 10K Ohm Type II
      d) 10K Ohm Type III
      e) 10K Ohm Type IV
      f) Linearized 10K Ohm Type V (FD w/11k shunt)
      g) Linearized 10K Ohm
      h) 1.8K Ohm
      i) 1K Ohm
      j) 20K Ohm
      k) 2.2K Ohm
      l) PT100
      m) PT1000
      n) Ni1000
      o) Voltage Input - 0-10 Vdc
      p) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
      q) Digital outputs
      r) Analog outputs 0-10 Vdc

l. Internal Clock
   1) Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
      a) Automatically synchronize system clocks daily from an operator-designated controller.
      b) The system shall automatically adjust for daylight saving time.
   2) Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
   3) The RTC shall provide the following: time of day, day, month, year, and day of week.
   4) The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on batteries

m. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection

n. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
o. Power Requirements. A line voltage version shall be available 230 VAC
p. In the case of power disruption, each BACnet/IP Fieldbus controller shall support power failure recovery within 10 seconds and resume operation from where the disruption had occurred
q. The BACnet/IP Fieldbus controller shall be able to be plenum mounted (UL2043 compliant)
r. The BACnet/IP Fieldbus controller shall meet the open class standard of UL916 permitting its installation without secondary enclosure where appropriate
s. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
   1) CE - EMCD 2014/30/EU
   2) CE LVD 2014/35/EU
   3) FCC CFR 47 Part 15 Class B
   4) RCM
   5) RoHS 2011/65/EU
   6) China RoHS SJ/T 11364-2014
   7) UL2043 (Plenum space mounting)
   8) UL916 Open-Energy Management equipment
   9) UL916 Energy Management equipment
t. Intelligent Space Sensor Interface - The BACnet/IP Fieldbus controllers shall support an RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
   1) It shall be possible to disable the RJ45 communication port

20. The BACnet/IP Fieldbus controller for remote IO
   a. It shall be possible to extend Inputs / Outputs required in NSC or BACnet/IP Fieldbus Controllers over the IP network
   b. The BACnet/IP IO expansion device shall be equipped with 2x 10/100bT Ethernet communication ports with active switch supporting the following configurations:
      1) Supporting IPv4 addressing
      2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
      3) It shall be possible to disable Ethernet port 2
   c. The BACnet/IP IO expansion device shall support daisy and RSTP topologies
   d. The BACnet/IP I/O expansion device shall be capable of sharing its local I/O resources with one or multiple applications distributed across one or multiple NSCs or BACnet/IP Fieldbus Controllers.
   e. The BACnet/IP I/O expansion device shall support BACnet Alarm and Trend locally
   f. Outputs of the BACnet/IP I/O expansion device shall support user configurable fallback value that is triggered in case of communication disruption.

F. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
   1. Sensing Element: 10k Type 3 Thermistor
2. Accuracy of ±0.2 °C (±0.4 °F)
3. Resolution: 0.1 or 1 degree display resolution
4. Range: 0 to 50 °C (32 to 122 °F)

G. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
1. Accuracy: ±2 % RH
2. Resolution: 0.1 or 1 % RH
3. Range: 0 % RH to 100 % RH

H. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
1. Accuracy: ±30 ppm ±2% of measured value
2. Range: 0 to 2,000 ppm
3. Operating elevation: 0 to 16,000 ft.
4. Temperature dependence: 0.11% FS per °F
5. Stability: <2% of FS over life of sensor (15 years)
6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

I. The Intelligent Space Sensor shall have the option for motion sensor

J. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
1. Space temperature
2. Cooling space temperature set point
3. Heating space temperature set point
4. Current heating or cooling mode
5. Current occupancy mode
6. Fan speed
7. Current time

2.6 BACNET FIELDBUS AND BACNET SDCUS

A. Networking
1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. IP To Field Bus Routing Devices
   a. A Network Server Controller shall be used to provide this functionality.
   b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
   c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination
1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
2. Each field bus shall have a termination resistor at both ends of each segment.
3. The field bus shall support the use of wireless communications.

C. Repeaters
1. Repeaters are required to connect two segments.
2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices
1. General Requirements
   a. Devices shall have a light indicating that they are powered.
   b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
   c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Advance Application Controllers (B-AAC)
1. The key characteristics of a B-AAC are:
   a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
   b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
   c. The application to be executed by a B-AAC is created by an application engineer using the vendor’s application programming tool.
   d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
   e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
   f. If local alarm message initiation is embedded, the B-AAC shall:
      1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the alarm message.
      2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
   g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
   h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
   i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
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j. Shall support the “Who is” and “I am.” BACnet services.
k. Shall support the “Who has” and “I have.” BACnet services.

2. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.

4. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.

5. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

6. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

7. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of
a power cycle to modify the sequence of controller immediately following a power cycle.

8. Local Interface
   a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Execute manual control of input and output points.
      3) View dynamic data.

F. Application Specific Devices
   1. Application specific devices shall have fixed function configurable applications.
   2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
   3. Application specific devices shall be BTL certified.

G. Room controllers
   1. For connected room solutions that do not require integrated lighting and blind busses built into a singular unit, the system shall include a BACnet MS-TP enabled controller specifically designed for room control.
   2. The controller shall communicate via BACnet MS-TP. It should also be capable of MODBUS RTU communication.
   3. The controller shall be capable of controlling fan coil units, cooling VVT zones with reheat, fin-tube radiators, cabinet heaters, radiant panel heaters, electric re-heat zones, terminal reheat, rooftop units (1H1C, 2H2C, 3H2C, MH2C), or heat pumps, if necessary.
   4. The controller shall house an onboard temperature sensor, and options for onboard humidity and occupancy sensor.
   5. The controller shall utilize a touch screen interface and have multiple options for casings and fascias. The screen shall be a TFT transmissive LED backlit LCD touchscreen with at least 5 color options.
   6. Controller will have password protection to prevent unauthorized access to the configuration menu parameters.
   7. The controller will have integrated Zigbee wireless communications with predefined profiles for Zigbee door and window switches, occupancy sensors, water leakage detectors, CO2 sensors, and additional temperature and humidity sensors.
   8. The controller will be capable of hosting at least 10 Zigbee sub devices.
   9. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes.

2.7 NETWORK THERMOSTAT

A. The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, zoning type systems employing reheat including local hydronic reheat valves, RTU/heat pump with economizer or other similar equipment.
B. The Networked Thermostat shall communicate over the BACnet Standard MSTP protocol. Communications shall be selectable locally at thermostat through the display.

C. The TEC shall be BTL listed/certified and carry the BTL Label. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

D. The network thermostat shall include a 4.2 inch LED backlit touch screen

E. The network thermostat shall provide the flexibility to support any one of the following inputs:
   1. Integral indoor air temperature sensor.
   2. Analog input for remote air temperature sensing.
   3. Universal input
   4. Remote indoor air temperature sensor.
   5. Two configurable binary inputs

F. The network thermostat shall provide 4 digit passcode security.

G. The network thermostat shall employ nonvolatile EEPROM for all adjustable parameters.

H. The network thermostat shall have a temperature accuracy of ±0.9°F/±0.5°C at 70.0°F/21.0°C typical calibrated.

I. The network thermostat shall have a humidity accuracy of ±5% RH from 20 to 80% RH at 50 to 90°F (10 to 32°C.)

J. The network thermostat shall provide user equipment visibility from a mobile device

K. Provide Johnson Controls TEC or approved equal as indicated on plans.

2.8 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors
   1. Basis of design Manufacturers: Veris Industries or BAS manufacturer equivalent
   2. All temperature devices shall use thermistors or RTDs accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
   3. Room Sensor: Standard space sensors shall be available in an [off white][black] enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
      a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
      b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series

5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series

6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series

7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series

8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Transmitters shall be accurate to +/- 3% at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have option of having an LCD display
11. Transmitter shall have option of being NIST certified
12. Transmitter shall have option of an integrated temperature sensor
13. Basis of Design: Veris HWL Series

C. Humidity Duct Transmitter
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Transmitters shall be accurate to +/- 3 % at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified
11. Transmitter shall have option of an integrated temperature sensor
12. Basis of Design: Veris HD Series

D. Humidity Outdoor Transmitter
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Transmitters shall be accurate to +/- 3% at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified
11. Transmitter shall have option of an integrated temperature sensor
12. Basis of Design: Veris HO Series

E. Carbon Dioxide Wall Transmitter:
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC][Protocol: Modbus or BACnet][with [SPDT Relay 1A@30VDC][temperature setpoint slider]
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: [32° to 122°F (CO2 only)][50° to 95°F (with humidity option)]
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Transmitter shall be available in an off white enclosure for mounting on a standard electrical box.
11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
12. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
13. Basis of Design: Veris CWL

F. Carbon Dioxide Duct Transmitter:
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have option of an LCD display
14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
15. Basis of Design: Veris CDL

G. Air Pressure Transmitters.
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element
3. Transmitter shall have 14 selectable ranges from 0.1 – 10” WC
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe
6. Transmitter shall be field selectable for Unidirectional or Bidirectional
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
11. Transmitter shall have an LCD display
12. Units shall be field selectable for WC or PA
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall have provision for a certification of NIST calibration
15. Basis of Design: Veris model PXU.

H. Liquid Differential Pressure Transmitters:
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Transmitter shall be microprocessor based
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
4. Transmitter shall have 4 switch selectable ranges
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping
9. Transmitter shall have an electronic port swap feature
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
a. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range  
b. Long term stability shall be ±0.25%  
c. Sensor temperature operating range shall be -4° to 185°F  
d. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing  
e. Proof pressure shall be 2x max. F.S. range  
f. Burst pressure shall be 5x max. F.S. range  

13. Transmitter shall be encased in a NEMA 4 enclosure  
14. Enclosure shall be white powder-coated aluminum  
15. Transmitter shall be available with a certification of NIST calibration  
16. Transmitter shall be preinstalled on a bypass valve manifold  
17. Basis of Design: Veris PW  

I. Current Sensors  
1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Basis of Design manufacturer is Veris Industries or BAS manufacturer equivalent  

J. Current Status Switches for Constant Load Devices  
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent  
2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.  
4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.  
5. Normally open current sensor output. 0.1A at 30 VAC/DC.  

K. Current Status Switches for Constant Load Devices (Auto Calibration)  
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent  
2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer  
3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.  
4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A  
5. Nominal Trip Point: ±40%, ±60%, or on/off (user selectable)  
6. Normally open current sensor output. 0.1A at 30 VAC/DC.  
7. Basis of Design: Veris Model H11D.  

L. Current Status Switches for Variable Frequency Drive Application  
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent  
2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and
mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.


4. Alarm Limits: ±20% of learned current in every 5 Hz freq. band

5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.

6. Normally open current sensor output. 0.1A at 30 VAC/DC.


M.

2.9 OCCUPANCY, DAYLIGHTING, AND PHOTO-ELECTRIC SENSORS

A. Refer to Division 26 Section "Lighting Control Devices" for equipment that relates to this Section.

2.10 AIRFLOW MEASURING STATIONS

A. Manufacturers:

1. Ebtron. [Gold Advantage II Model GT] [Advantage Silver Model ST]

2. Air Monitoring Corporation.

B. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans.

1. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.

C. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

1. Each sensor assembly shall contain two individually wired, hermetically sealed, bead-in-glass thermistors.

2. Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

3. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.

4. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.

5. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

6. Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

7. Devices using less than two thermistors in each sensor assembly are not acceptable.

8. Devices using platinum wire RTDs are not acceptable.
9. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
10. Pitot tubes and arrays are not acceptable.
11. Vortex shedding devices are not acceptable.

D. All Sensor Probes

1. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
2. Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
3. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.
   a. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
4. Temperature accuracy shall be +/-0.15 degrees F over the entire operating temperature range of minus 20- to 160-degrees F.
5. The operating humidity range for each sensor probe shall be 0% RH to 99% RH (non-condensing).
6. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
7. Each sensor assembly shall not require matching to the transmitter in the field.
8. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

E. Duct and Plenum Probes

1. Probe shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
2. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
   a. Insertion mounted through the side or top of the duct.
   b. Internally mounted inside the duct or plenum.
   c. Standoff mounted inside the plenum.
3. The number of sensor housings provided for each location shall be as follows:
   a. Duct or Plenum Area (sq. ft.)    Total # of Sensors/Location
      b.  < 2                     4
      c.  2 to < 4                 6
      d.  4 to < 8                 8
      e.  8 to < 16                12
      f.  >= 16                   16
4. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

F. Transmitters
1. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
2. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
3. The transmitter shall have a power switch and operate on 24 VAC (isolation not required).
   a. The transmitter shall use a switching power supply fused and protected from transients and power surges.
   b. The transmitter shall use “watch-dog” circuitry to assure reset after power disruption, transients and brownouts.
4. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
5. The operating temperature range for the transmitter shall be minus 20- to 120-degrees F. The transmitter shall be installed at a location that is protected from weather and water.
6. The transmitter shall be capable of communicating with other devices using one of the following interface options:
   a. Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-V dc to 10-V dc / 4-mA to 20-mA (4-wire), output impedance compatible with DDC system input.
7. The transmitter shall be capable of accepting an infrared interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).
   a. Provide PDA upload/download software.
   b. Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rates, individual sensor temperatures and the average temperature received from the transmitter.
   c. Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.
   d. Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.
   e. Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to a PDA for upload to one or more transmitters.

G. The ATMD shall be UL listed as an entire assembly.

H. The manufacturer’s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.

I. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer’s placement requirements.
J. Select Ebtron Gold or Silver above or determine whether a lower cost solution like duct-mounted below can be used. Airflow stations are advisable over airflow arrays for accuracy.

2.11 DUCT-MOUNTED AIRFLOW STATION

A. Manufacturers:
   1. Air Monitor Corporation.
   2. Dietrich-Standard.

B. Combination of air straightener and multiport, self-averaging, Pitot-tube station and/or airflow measuring arrays.

C. Casing: Galvanized-steel frame.

D. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.

E. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.12 FLOW METERS

A. Steam/Liquid Differential Pressure Transducers: (flow only)
   1. Manufacturers:
      a. Tobar.
      b. ITT Barton.
      d. ABB.
      e. Siemens.
      f. Rosemont/Fischer.
      g. Honeywell.

   2. Each differential pressure transducer shall be selected and calibrated for operations between 0- and 125-% of the normal differential pressure and up to 150-psig line pressure. The calibration point shall be rounded upward to the nearest 10-inches wg (for spans less than 200-inches wg) or to the nearest 5-psig for larger spans. Calibration date shall be included on an embossed tag attached to each transmitter.

   3. The accuracy, including linearity, hysteresis and repeatability, of the transducer for measuring differential pressure shall be better than 0.25-% of the span stated above throughout a minimum of a 6:1 turndown. Turndown ratio shall be based on the actual flow span.

   4. The transducer shall not be damaged by pressures of up to 500-psig on either side of the transducer and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.

   5. Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
6. Span and zero shall be individually adjustable.
7. Shall be 2-wire and 4- to 20-mA output.

B. Steam/Liquid Differential Pressure Transducers: (pressure only)
1. Manufacturers:
   a. Tobar.
   b. ITT Barton.
   d. ABB.
   e. Siemens.
2. Each differential pressure transducer shall be selected and calibrated for operations between 0- and 200-% of the normal differential pressure. The calibration point shall be rounded upward to the nearest 10-inches wg (for spans less than 200-inches wg) or to the nearest 5-psig for larger spans. Calibration date shall be included on an embossed tag attached to each transducer.
3. The accuracy, including linearity, hysteresis and repeatability, of the transducer for measuring differential pressure shall be better than 2-% of the span stated above throughout a minimum of a 4:1 turndown. Turndown ratio shall be based on the actual differential span.
4. The transducer shall not be damaged by pressures of up to 500-psig on either side of the transducer and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.
5. Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
6. Span and zero shall be individually adjustable.
7. Shall be 2-wire and 4- to 20-mA output.

C. Indication Gauges for Steam/Liquid Pressure Transducers:
1. Manufacturers:
   a. Beckman.
   b. Moore.
   c. Testoterm.
   d. Dwyer.
2. Each transducer shall come with an indicating gauge that reads in GPM for flow measurement or inches water column (in. wg) for pressure sensing. The gauge shall be analog differential pressure type piped in parallel to the transducer.
3. The analog pressure gauge shall be selected and calibrated for the same span as the transducer it serves.
4. The accuracy, including linearity, hysteresis and repeatability, of the gauge for measuring differential pressure shall be better than 3% of the span stated above throughout its span. Calibration data shall be included on an embossed tag attached to each gauge.
5. The gauge shall not be damaged by pressures of up to 500-psig on either side of the gauge and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.

6. Scale shall be a minimum of 4.5-inches long. Furnish and install two bleed fittings for each gauge and mounting brackets appropriate for the installation location.

7. Gauges shall be field mounted. Provide a phenolic identification tag for each gauge and indicator.

D. Steam/Liquid Flow Sensors: (differential pressure type)

1. Manufacturers:
   a. Preso.
   b. Gerand.

2. Unidirectional sensors shall be of the venturi-type or velocity pressure type. They shall be constructed of stainless steel, sized to the system's range of flow, and have an accuracy of 0.5-%.

3. Bi-directional sensors shall be of the velocity pressure type. They shall be constructed of stainless steel, sized to the system's range of flow, and have an accuracy of 0.5-%.

E. Three Valve Manifold for Steam/Liquid Pressure Transducers:

1. Manufacturers:
   a. D/A Manufacturing.

2. Provide a three-valve manifold for each transducer. Pressures of up to 500-psig shall not damage the manifold. All wetted parts shall be inert in the presence of up to a 50% concentration of ethylene or propylene glycol in water.

3. The manifold shall be designed for direct mounting on the transducer it serves and utilizes two quarter-turn valves to provide zeroing, blocking and normal service modes.

F. Liquid Flow Meters: (Electro-Magnetic Type)

1. Manufacturers (Water or Glycol/Water):
   a. ABB.
   b. Siemens.
   c. EMCO.
   d. Rosemount.
   e. Krohne.

2. Manufacturers (Steam Condensate)
   a. ABB.
   b. Siemens.
   c. EMCO.
   d. Rosemount.
   e. Krohne.
3. The meter system shall consist of a primary flow sensor and transmitter. The flow sensor shall be equipped with 150-lb. flanges. The meter system shall be installed with all necessary grounding components and gaskets per manufacturer’s instructions. The meter shall be capable of bi-directional operation. The meter shall be sized appropriately for the range of flow for the system. The electrodes shall be stainless steel or Hasteloy C. The transmitter shall be provided with a remote mounting bracket, cable, integral LCD display, NEMA 4X housing, and shall indicate flow rate, totalize flow, and shall have an isolated 2-wire 4-20 mA linear output signal and a pulsed output signal for totalization. The transmitter shall be capable of being field calibrated and reprogrammed from the outside housing via magnetic probe or integral keypad menu switching. Unit electronics shall have noise immunity. The primary flow sensor and transmitter shall be mounted in accessible locations. Unit shall have the capability to maintain flow total in non-volatile memory. The flow meter shall be provided with a 1-year warranty and application non-degraded performance guarantee. The flow meter and transmitter as a unit shall have the following minimum characteristics:

   a. Flow meter Liner:
   b. Heating hot water, domestic hot water, and other water systems operating at or above 110-degrees F: Teflon
   c. Chilled water, domestic cold water, and other water systems operating below 110-degrees F: Polyurethane
   d. Steam condensate: Teflon up to 300-degrees F, Ceramic over 301-degrees F, and as suitable for the expected fluid conditions.
   e. Accuracy:
   f. At 1- to 33-feet per second velocity: plus or minus 0.5-% of rate.
   g. At 0.3-feet per second velocity: ±2% of rate.
   h. Each unit shall be factory calibrated for the specified flow and shall be calibrated in both directions if the application is bi-directional. Calibration shall be a minimum of three point. Specific performance test data shall be furnished with the meter.
   i. Each meter shall provide two analog 4- to 20-mA signals or a single 4-to 20-mA signal and a digital contact closure on reverse flow.
   j. Meters for steam condensate shall be capable of sensing flow with condensate conductivity down to 6 µS/cm.

4. Provide a phenolic tag for each transmitter to identify service and meter ID number (i.e. SECONDARY CHILLED WATER FLOW, FM-1, etc.).

2.13 DDC BTU METERING

A. DDC BTU metering shall be accomplished using the following equipment at each metering point:

1. One (1) liquid flow meter unit with current-loop transmitter as specified elsewhere in this section.
   a. Flow meter range shall be 125% of the maximum expected flow capacity.

2. Two (2) high-precision matched temperature sensor assemblies with current-loop transmitters. Sensors with stainless steel wells shall be installed in each respective supply and return pipe as shown on project drawings for ferrous piping (use copper or brass wells for copper piping).
a. Manufacturers: MINCO and TCS
b. Temperature sensors shall be a matched pair selected for this application.
c. Temperature sensor accuracy shall be plus or minus 0.1-degrees F at calibration temperature. Calibration temperature for chilled water is 44.0-degrees F and for heating hot water is 180.0-degrees F.

3. These devices shall be wired to a local DDC panel. Calculations for instantaneous and totalized load shall be incorporated into the panel control code, and the necessary virtual points shall be created to allow remote monitoring and trending via the DDC system.

B. DDC shall perform BTU computations using linear, square law, or multi-point linearization data interpretation, as needed, based on the flow meter used. Inputs shall include:

1. 4- to 20-ma signal from hydronic flow meter
2. 4- to 20-ma signal from two, high-accuracy, immersion temperature sensors

C. Input devices shall be rated for the environment in which they are installed. DDC shall perform rate of flow calculations as well as monitor the flow and totalize it weekly, monthly, and yearly. These values shall be available at the BAS in graphical format for operator monitoring. Flow rate alarms shall be programmed for low flow and high flow conditions.

D. Provide an equipment tag for each transmitter device to identify service and ID number (i.e. CHILLED WATER BTU METER – ANNEX BUILDING, etc.).

E. Water Control Valves

1. Ball Valves
   a. ½” to ¾” Ball Valve
      1) Forged brass body rated at no less than 600 psi, chrome plated brass ball with blowout proof stem or optional stainless steel ball with blowout proof stem,
      2) Valves are to be in two-way and three-way configurations.
      3) Connection: Female NPT end fittings, Teflon® PTFE seat, characterizing disc glass filled PEEK providing equal percentage flow curve on two-way valve.
      4) Operating Temperature 20…250°F chilled or hot water with up to 60% glycol solution.
      5) Two-way and Bypass port should be ANSI Class IV (0.01% of Cv) seat leakage.
      6) Rangeability must be at least 300:1.
      7) Tool-less actuator connection.
      8) System Static Pressure Limit should be 600 psig (4137 Pa)
      9) Basis of Design: Schneider Electric VBB/VBS Ball Valves, or BAS manufacturer equivalent
   b. ½” to 3” 2-way and ½” to 2” 3-way Ball Valves
      1) Valves must be for control of hot or chilled water, or solutions of up to 50% glycol.
      2) Ball valves must have close-offs of 40…130 psi depending on size.
      3) Valves will provide CVs from 0.33…266 depending on size.
      4) Valve characterizing insert, is to be made of glass-filled Noryl™ and provide equal percentage flow.
      5) Valve body is to be made of forged brass ASTM B283-06 and rated for static pressure of 360 psi at fluid temperatures of 20…250°F (-7…121°C).
6) All valves are to have balls made of nickel/chromium plated brass with two-way valves having stainless steel balls as an option. All valve stems are to be stainless steel with reinforce Teflon® EPDM O-ring seals.

7) 2-way valves are to be ANSI Class IV (0.01% of Cv) shutoff. 3-way valves are to be ANSI Class IV (0.01% of Cv piped coil-side outlet to the port A only.

8) Fluid (water) temperature are a minimum 20°F (-7°C) and a maximum of 250°F (121°C).

9) Basis of Design: Schneider Electric VB-2000, or BAS manufacturer equivalent

2. Globe Valves (Bronze ½” to 2”)
   a. Control Valves: Factory fabricated, with body material, and pressure class based on maximum pressure and temperature rating of piping system with a body rating of not less than 400 psig at 150°F, 321 psig at 281°F per ANSI B16.15.
   b. Valves two way NPS 2” and Smaller: Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:
      1) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, soft seal, and bronze seat, renewable packing cartridge, and screwed/sweat/flared ends. Valves shall have allowable media temperature of 20°F …281°F to assure reliability with dual temperature applications.
      2) Heavy duty bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, soft seal, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …340°F to assure to assure reliability with dual temperature applications.
      3) High temperature bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …400°F.
   c. Two-way fluid system globe valves shall have the following characteristics:
      1) Rangeability: Greater than 100:1 for all valves with flow coefficients of 0.4 and higher to provide stable control under light load conditions.
      2) Maximum Allowable Seat Leakage: Standard and heavy duty valves must be designed to meet ANSI Class V (0.0005 ml per minute per “of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI Class IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. High temperature valves must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
      3) The valve must be able to operate with a full-open operating differential of no less than 87 psi.
      4) Flow Characteristics: Modified equal percentage characteristics for standard duty water applications and modified linear for heavy duty and high temperature steam applications with gradual opening for light loads.
      5) Sizing:
         a) Two Position Water: Water: Line size or size using a differential pressure of 1 psi.
         b) Modulating Water: 5 PSI or twice the load pressure drop.
         c) Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure up to 15 psig and 42% of absolute (gage pressure + 14.7) inlet pressure above 15 psig inlet.
         d) 100 psi saturated steam maximum inlet pressure for heavy duty bronze body globe valves ½”…2”.
         e) 150 psi saturated steam maximum inlet pressure for high temperature bronze body globe valves ½”…2”. 

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f) 35 psi saturated steam maximum inlet pressure for standard duty bronze body globe valves ½”…2”.

d. Valves 3-Way mixing (two inlets and one outlet) NPS 2” and Smaller:
   1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:
      a) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, and bronze seat, renewable packing cartridge, and screwed or sweat ends. Valves shall have allowable media temperature of 20°F…281°F to assure reliability with dual temperature applications.
      b) Heavy duty bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, and 316 stainless steel seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …340°F to assure reliability with dual temperature applications.

e. 3-Way mixing hydronic system globe valves shall have the following characteristics:
   1) Rangeability: Greater than 100:1 for all valves to provide stable control.
   2) Maximum Allowable Seat Leakage: A port must be designed to meet ANSI Class V (0.0005 ml per minute per “of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. B port must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
   3) The valve must be able to operate with a full-open operating differential of 87 psi.
   4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
   5) Sizing: Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.

f. Valves 3-Way diverting (one inlet and two outlets) NPS 2” and Smaller:
   1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Valves must be designed specifically for diverting service, and mixing valves designed for mixing service must not be used for diverting applications. Material grade properties must meet the fluid temperature and pressure requirements:
      a) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, and bronze seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …281°F to assure reliability with dual temperature applications.

g. 3-Way diverting hydronic system globe valves shall have the following characteristics:
   1) Rangeability: Greater than 100:1 for all valves to provide stable control under light load conditions.
   2) Maximum Allowable Seat Leakage: ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
   3) Maximum Allowable Pressure Differential: 35 psi in an open position.
   4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
   5) Sizing:
      a) Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.
h. Required Certifications: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals), Canadian Registration Number.

i. Valve and Operator: To assure maximum performance and operation of the valve assembly both the valve and the actuator must be tested and approved by the valve manufacturer to assure compatibility of all components and performance to the specifications.
   1) Basis of Design: Schneider Electric Venta VB-7000, or BAS manufacturer equivalent

3. Butterfly Valves
   a. Valve body are to be polyester coated iron ASTM A126 lug mating with ANSI class 125/150 flanges.
   b. Disc Type: Ductile iron nylon 11 coated.
   c. Valve Stem:
      1) 2…8” 416 stainless steel double D stem.
      2) 10…12” 316 stainless steel double D stem.
      3) 14” and larger: stainless steel round shaft woodruff key slot.
   d. Valve seat: EPDM tongue and groove seat and molded O-ring flange seat
   e. Flow Characteristics: Modified equal percentage.
   g. Valve fluid temperature rating: -40…250°F (-40…121°C) 9. Valve will have two (2) inch extended neck (because of heat). 10. Valve must accept pneumatic or electric/electronic actuators 11. Valves must have a minimum of a two (2) year warranty.
   h. Valve will have two (2) inch extended neck (because of heat).
   i. Valve must accept pneumatic or electric/electronic actuators.
   j. Valves must have a minimum of a two (2) year warranty.
   k. Basis of Design: BAS manufacturer equivalent

4. Flanged Valves
   a. Bodies: Shall be American Factory fabricated with ASTM A 126 Class B cast iron body material with the pressure class within the maximum pressure and temperature rating of the piping system. (125 body rating with not less than 200 psig at 150°F, decreasing to 169 psig at 281°F per ANSA B16.1)
   b. Serviceability: 2-Way valve operators, stem and plug assemblies and spring-loaded PTFE/EPDM valve stem packing cartridges must be removable for future replacement to restore the valves back to their original condition.
   c. Construction: Material grades must meet the fluid temperature and pressure requirement temperatures of 20°F …281°F to assure reliability throughout all application temperature ranges.
   d. Packings: Shall be cartridges suitable for replacement as units withstandig the full operating temperature ranges, including daily and seasonal fluctuations of water, 60% glycol and steam fluids.
   e. Characteristics
      1) Rangeability: Two way,100:1 and greater for stable control under light load.
      2) Shutoff, 2-Way: Leakage allowed: ANSI Class IV (0.01% of max flow)
      3) 3-Way: Leakage allowed: ANSI Class III (0.1% of max flow)
      4) Flow curves: 2-Way modified equal percentage characteristic.
      5) Mixing and Diverting: Linear, modified with gradual opening for light loads.
f. Piping
   1) Diverting valves, with the common port at the bottom can be used for mixing.
   2) Mixing valves with the common port at the end must not be used for diverting applications.

g. Sizing
   1) Two Position Water: Line size or size using a differential pressure of 1 psi.
   2) Modulating Water: 5 PSI or twice the load pressure drop
   3) Steam, 2-Way: maximum pressure drop across the valve at a maximum flow of 80 percent of inlet pressure up to 15 psig. Above 15 psig inlet, 42% of absolute (gage pressure + 14.7) inlet pressure.

h. Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals)
   1) Basis of Design: Schneider Electric VB-8000 and VB-9000 valves, or BAS manufacturer equivalent

F. Steam Control Valves
   1. ½”…2” Steam Service Designed Globe Valve
      a. Body material, and pressure class based on maximum pressure and temperature rating of piping system with a body rating of not less than 400 psig at 150°F, 321 psig at 281°F per ANSI B16.15
      b. High temperature spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:
         1) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, soft seal, and bronze seat, renewable packing cartridge, and screwed/sweat/flared ends. Valves shall have allowable media temperature of 20°F …281°F to assure reliability with dual temperature applications.
         2) Heavy duty bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, soft seal, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …340°F to assure to assure reliability with dual temperature applications.
         3) High temperature bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …400°F.
      c. Two-way fluid system globe valves shall have the following characteristics:
         1) Rangeability: Greater than 100:1 for all valves with flow coefficients of 0.4 and higher to provide stable control under light load conditions.
         2) Maximum Allowable Seat Leakage: Standard and heavy duty valves must be designed to meet ANSI Class V (0.0005 ml per minute per " of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI Class IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. High temperature valves must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
         3) The valve must be able to operate with a full-open operating differential of no less than 87 psi.
4) Flow Characteristics: Modified equal percentage characteristics for standard
duty water applications and modified linear for heavy duty and high
temperature steam applications with gradual opening for light loads.

5) Sizing:
   a) Pressure drop across steam valve at a maximum flow of 80 percent of
      inlet pressure up to 15 psig and 42% of absolute (gage pressure + 14.7)
      inlet pressure above 15 psig inlet.
   b) 100 psi saturated steam maximum inlet pressure for heavy duty bronze
      body globe valves ½”...2”.
   c) 150 psi saturated steam maximum inlet pressure for high temperature
      bronze body globe valves ½”...2”.
   d) 35 psi saturated steam maximum inlet pressure for standard duty
      bronze body globe valves ½”...2”.

6) Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC),
   RoHS (Restriction of Hazardous Substances) and REACH (Regulation,

7) Basis of Design: Schneider Electric VB-7000 valves, or BAS manufacturer
    equivalent

2. 2-½”...6” Steam Service Designed Globe Valves

   a. Bodies: Shall be American Factory fabricated with ASTM A 126 Class B cast iron
      body material with the pressure class within the maximum pressure and temperature
      rating of the piping system. (125 body rating with not less than 200 psig at 150°F,
      decreasing to 169 psig at 281°F per ANSA B16.1).

   b. Serviceability: 2-Way valve operators, stem and plug assemblies and spring-loaded
      PTFE/EPDM valve stem packing cartridges must be removable for future
      replacement to restore the valves back to their original condition.

   c. Construction: Material grades must meet the fluid temperature and pressure
      requirement temperatures of 20°F ...281°F to assure reliability throughout all
      application temperature ranges.

   d. Packings: Shall be cartridges suitable for replacement as units withstanding the full
      operating temperature ranges, including daily and seasonal fluctuations of water,
      60% glycol and steam fluids.

   e. Characteristics
      1) Rangeability: Two way, 100:1 and greater for stable control under light load.
      2) Shutoff, 2-Way: Leakage allowed: ANSI Class IV (0.01% of max flow)
      3) Flow curves: 2-Way modified equal percentage characteristic.

   f. Sizing
      1) Steam, 2-Way: maximum pressure drop across the valve at a maximum flow
         of 80 percent of inlet pressure up to 15 psig. Above 15 psig inlet, 42% of
         absolute (gage pressure + 14.7) inlet pressure.

   g. Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS
      (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation,
      Authorization, and Restriction of Chemicals).
      1) Basis of Design: Schneider Electric VB-8000 and VB-9000 valves, or BAS
         manufacturer equivalent

G. Control Valve Actuators
1. ½” to ¾” Ball Valve Actuators
   a. Size for torque required for valve close-off pressure for system design.
   b. Coupling: Direct coupled to valve body without use of external devices/tools
   c. Auxiliary End Switch (optional) to be SPST 24 Vac/Vdc, 101 mA to 5 mA maximum on selected two-position models.
   d. Controller Signal Two-position, Floating or Proportional (0…5 Vdc, 0…10 Vdc, 5…10 Vdc, or 4…20 mA dc). Design allows for change via DIP switches without removal of cover.
   e. Manual operating lever and position indicator must be standard.
   f. Power Requirements: 24 Vac for floating, proportional, and 110…230 Vac for two position multi-voltage types
   g. Actuators must be available with either Spring Return (SR) or Non-Spring Return (NSR) models.
   h. Operating Temperature Limit Floating is to be 32…140°F (0…60°C) Proportional 32…140°F (0…60°C) Two-Position 32…169°F (0…76°C)
   i. Wiring (depending on model) Removable Terminal Block, 10 ft. (3.05 m) Plenum Cable, 18 in. (45 cm) Appliance Wire
   j. Locations must be rated NEMA 2, IEC IP 31. (Indoor Use Only.) Actuators with terminal block or plenum cable leads are plenum rated per UL file number E9429.
   k. Agency Listings: ISO 9001, cULus, and CE.
      1) Basis of Design: Schneider Electric VBB/VBS, or BAS manufacturer equivalent
2. ½” to 3” 2-way and ½” to 2” 3-way Ball Valves Actuators
   a. Size for torque required for valve close-off pressure for system design.
   b. Actuators are to be available in spring return (SR) and non-spring return (NSR) models. Spring Return (SR) actuators are to provide a choice to return direction.
   c. Actuators are to be available in models for two-position, floating and proportional control.
   d. All actuator models are to be equipped with pigtail leads, manual override, and auxiliary switch(es)
   e. Operating temperatures' Floating Non-Spring Return (NSR) with 33 lb.-in. of torque must be -25 to 130 °F (-32 to 55°C). All other actuators are to -22 to 140 °F (-30 to 60 °C)
   f. Actuators must be NEMA 2 rated.
   g. Agency Listings: ISO 9001, cULus, and CE.
      1) Basis of Design: Schneider Electric VB-2000, or BAS manufacturer equivalent approved equal.
3. ½" to 2" Bronze, Linear Globe Valve Actuators/67 or 78 lbs. force
   a. Actuator must have bi-color LED status indication for motion indication, auto calibration and alarm notification.
   b. When the actuator is properly mounted must have a minimum of a NEMA 2 (IP53) rating.
   c. Actuators are to be non-spring return.
   d. Actuators are to be floating (used for two-position) or proportional models.
   e. Proportional models will have optional models with a position output signal with field selectable 2…10 Vdc and 0…10 Vdc input signals and selectable input signal direct or reverse acting.
f. Actuator must have auto calibration which provides precise control by scaling the input signal to match the exact travel of the valve stem

g. Actuators must come in models with Pulse Width Modulated (PWM) with field selectable 0.59 to 2.93 sec and 0.1 to 25.5 sec input signal ranges with a position output signal

h. Actuators must have manual override with automatic release.

i. Models with position feedback output signal include field selectable 2…10 Vdc or 0…5 Vdc output signal

j. Removable wiring screw terminal with ½” conduit opening.

k. Actuator operating temperature ranges:
   1) When controlling fluid up to 266°F (130°C) = ambient air temperature is to be 23…131°F (-5…55°C)
   2) Fluid up to 281°F (138°C) = 23…127°F (-5…53°C)
   3) Fluid up to 340°F (171°C) = 23…115°F (-5…46°C)
   4) Fluid up to 400°F (204°C) = 23…102°F (-5…39°C)

l. Actuator agency Listings: cUL-us LISTED mark, NEMA 2, NEC class 2 FCC part-15 class B, Canadian ICES-003, ESA registered, Plenum rated per UL 20430
   1) Basis of Design: Schneider Electric MG350V, or BAS manufacturer equivalent

4. ½” to 2” Bronze, Linear Globe Valve Actuators/105 lbs. force
   a. Actuators must have Two-Position, Floating, and Proportional models.
   b. Proportional models will a controller input signal of either a 0…10 Vdc, 2…10 Vdc, 4…20 mAdc, 0…3 Vdc, or 6…9 Vdc. Control function direct/reverse action is switch selectable on most models.
   c. Actuator force is to be 105 lb. (467 newton) with ½” (13 mm) nominal linear stroke
   d. Power requirements 24 Vac, 120 Vac or 230 Vac depending on model.
   e. Actuator housings rated for up to NEMA 2/ IP54.
   f. Actuator is to have overload protection throughout stroke.
   g. Actuator operating temperature -22…140°F (-30…60°C) up to a maximum valve fluid temperature of 366°F (186°C).
   h. Actuator must automatically set input span to match valve travel.
   i. Actuator must have manual override to allow positioning of valve and preload.
   j. Actuator is to be spring return.
   k. Actuator is to mount directly to valves without separate linkage.
   l. Actuator agency Listings: UL 873, CUL: UL
      1) Basis of Design: Schneider Electric SmartX Mx51-7103, or BAS manufacturer equivalent

5. ½” to 2” Bronze, Linear Globe Valve Actuators/220 lbs. force
   a. Actuators must have Two-Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0…10 Vdc, 2…10 Vdc, 4…20 mAdc, or 6…9 Vdc. Control function direct/reverse action is jumper selectable
   b. Actuator is to be spring return.
   c. Actuator will have 220 lb. force (979 newton) with ½” (13 mm) or 1” (25 mm) nominal linear stroke
d. Feedback on proportional model with 2…10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.

e. Actuator operating temperature is 0…140°F (-18…60°C) up to a maximum valve fluid temperature of 281°F (138°C), 0…120°F (-18…49°C) up to a maximum valve fluid temperature of 300°F (149°C), 0…100°F (-18…38°C) up to a maximum valve fluid temperature of 340°F (171°C), 0…90°F (-18…32°C) up to a maximum valve fluid temperature of 366°F (186°C).

f. Actuator must automatically set input span to match valve travel

g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.

h. Actuator housings rated for up to NEMA 2/ IP54

i. Actuator must have manual override to allow positioning of valve and preload

j. Actuator is to mount directly to valves without separate linkage.

k. Actuator agency Listings: UL 873, CUL: UL

1) Basis of Design: Schneider Electric SmartX Mx51-720x, or BAS manufacturer equivalent

6. ½” to 2” Bronze, Linear Globe Valve Actuators with linkage SR

a. Actuators with 35, 60, 133, or 150 lb.-in of force depending on model.

b. Actuator housings rated for up to NEMA 2/ IP54 with a 150 lb.-in. rated a NEMA 4.

c. Actuators are to be spring return.

d. Actuators are to have Two-position, Floating and Proportional models.

e. Actuators must have overload protection throughout rotation.

f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.

g. Actuator agency listings: UL-873, C22-2 No.24-83, CUL0

1) Basis of Design: Schneider Electric SmartX, or BAS manufacturer equivalent

7. ½” to 2” Bronze Body, Linear Globe Valve Actuators with linkage SR & NSR

a. Actuators are to be either floating SPDT control or proportional control 0…10, 2…10 Vdc or 4…20 mA with a 500-ohm resistor included.

b. Actuators are to be direct/reverse with selectable DIP switches.

c. Actuators are to have 90 lb. (400N), 180 lb. (800N), or 337 lb. (1500N) of force on Non-Spring Return (NSR) 157 lb. of force on the Spring Return model. Note: Not every actuator is for every valve.

d. Actuators are to be powered with 24 Vac or 24 Vdc.

e. All Non-Spring Return (NSR) actuators are to be NEMA 2, vertical mount only. Spring Return (SR) actuators are to have NEMA 4 models.

f. Actuators must have manual override to allow positioning of the valve.

g. Actuators must have selectable valve sequencing and flow curves of either equal percentage or linear.

h. Actuators must have internal torque protection throughout stroke.

i. Actuator operating temperature is 14…122°F (-10…50°C) for chilled water applications, 14…113°F (-10…45°C) up to a maximum valve fluid temperature of 281°F (138°C), 14…107°F (-10…42°C) up to a maximum valve fluid temperature of 300°F (149°C), 14…100°F (-10…38°C) up to a maximum valve fluid temperature of 340°F (171°C), 14…90°F (-10…32°C) up to a maximum valve fluid temperature of 366°F (186°C).

j. Actuator agency listings (North America) UL873, cULus, RCM, CE
1) Basis of Design: Schneider Electric Forta M400A-VB, M800A-VB, M900A and M1500x-VB screw mounted on Venta VB7000s, or BAS manufacturer equivalent

8. 2 ½” to 6” Cast Iron Flanged Globe Valve Linear Actuators with linkage
   a. Actuators are to be either floating SPDT control or proportional control 0…10, 2…10 Vdc or 4…20 mA with a 500-ohm resistor included.
   b. Actuators are to direct/reverse acting with selectable DIP switch.
   c. Actuators are to have 180 lb. (800N) or 337 lb. (1500N) of force.
   d. Actuators will need a 24 Vac or Vdc power supply.
   e. Actuators are to be rated NEMA 2, vertical mount only.
   f. Actuators must have manual override to allow positioning of the valve.
   g. Actuators must have selectable valve sequencing and flow curves of either equal percentage to linear.
   h. Actuators must have Internal torque protection throughout stroke.
   i. Actuator operating temperature is 14…122°F (-10…50°C) for chilled water applications, 14…113°F (-10…45°C) up to a maximum valve fluid temperature of 281°F (138°C), 14…107°F (-10…42°C) up to a maximum valve fluid temperature of 300°F (149°C).
   j. Actuator agency listings (North America) UL873, cULus, RCM, CE

1) Basis of Design: Schneider Electric Forta M800A and M1500A, or BAS manufacturer equivalent

9. 2-½” to 6” Cast Iron Flanged Globe Valve Actuators/220 lbs. force.
   a. Actuators must have Two-Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0…10 Vdc, 2…10 Vdc, 4…20 mAdc, or 6…9 Vdc. Control function direct/reverse action is jumper selectable.
   b. Actuator is to be spring return.
   c. Actuator will have 220 lb. force (979 newton) with ½” (13 mm) or 1” (25 mm) nominal linear stroke.
   d. Feedback on proportional model with 2…10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.
   e. Actuator must automatically set input span to match valve travel.
   f. Actuator Operating temperature 0…140°F (-18…60°C) up to a maximum valve fluid temperature of 300°F (149°C).
   g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
   h. Actuator housings rated for up to NEMA 2/IP54.
   i. Actuator must have manual override to allow positioning of valve and preload.
   j. Actuator is to mount directly to valves without separate linkage.
   k. Actuator agency Listings: UL 873, CUL: UL
      1) Basis of Design: Schneider Electric SmartX Mx61-720x, or BAS manufacturer equivalent

10. 2-½” to 6” Cast Iron Flanged Globe Valve Actuators with linkage SR.
    a. Actuators with 60, 133, or 150 lb.-in of force depending on model.
b. Actuator housings rated for up to NEMA 2/ IP54 with a 150 lb.-in. rated a NEMA 4.
c. Actuators are to be spring return.
d. Actuators are to have Two-position, Floating and Proportional models.
e. Actuators must have overload protection throughout rotation.
f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.
g. Actuator agency listings: UL-873, C22-2 No.24-83, CUL0.
h. Basis of Design: Schneider Electric SmartX, or approved equal.

11. 2” to 18” 2-Way and 2” to 16” 3-Way Linear Butterfly Valve Actuator with linkage NSR
   a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 4, manual override (hand wheel) two auxiliary switches, and built-in heater.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac and 120 Vac models.
   d. Actuators must have Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another. 
   e. Actuator operating temperature shall be -40…150°F (-40…60°C).
   f. Actuator agency listings (North America) UL, CSA and CE
      1) Basis of Design: Schneider Electric S70, or BAS manufacturer equivalent

12. 2” to 4” 2-Way and 3-Way Butterfly Valve Actuators SR
   a. The butterfly valve actuators are to be Spring Return (SR) two-position and proportional taking 2…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 2.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac models.
   d. Actuators shall have two SPDT auxiliary switch models.
   e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another. 
   f. Actuator operating temperature shall be -22…140°F (-12…60°C).
   g. Actuator agency listings (North America) UL, CSA and CE
      1) Basis of Design: Schneider Electric SmartX Mx-41-7153, or BAS manufacturer equivalent

13. 2” to 6” 2-Way and 3-Way Butterfly Valve Actuators NSR
   a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 2.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac models.
   d. Actuators shall have two SPDT auxiliary switch models.
   e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another. 
   f. Actuator operating temperature shall be -4…122°F (-2…50°C).
INSTRUMENTATION AND CONTROL FOR HVAC

14. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS system supplier. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.

15. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.

16. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.

17. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.

18. Control and smoke dampers shall be Ruskin, or approved equal.

19. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

H. Damper Actuators

1. Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque.

2. Direct-coupled damper actuators must have a five-year warrantee.

3. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.

4. Direct-coupled damper actuators should accommodate 3/8”, ½” 1.05” round or 3/8”…½” and ¾” square damper shafts.

5. Actuator operating temperature minimum requirements: 44, 88 and 133 lb.-in. are -25°F…130°F (−32°C…55°C). The 30, 35, 60, 150 and 300 lb.-in. are -25°…140°F (-30°C…60 °C). The 270 are -22°…122°F (-30°C…50 °C).

6. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.

7. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.

8. Non-Spring Return Actuators shall stay in the position last commended by the controller with an external manual gear release to allow positioning when not powered.

9. Power Requirements: 24Vac/dc [120Vac][230Vac]

10. Proportional Actuators controller input range from 0…10 Vdc, 2…10 Vdc or 4…20 mA models.

11. Housing: Minimum requirement NEMA type 2 with NEMA type 4 available for applications requiring higher ratings.

12. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).

13. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or “gang” mount.

14. Agency Listings: ISO 9001, cULus, CE and CSA

   1) Basis of Design: Schneider Electric SmartX Actuators, or BAS manufacturer equivalent
I. Airflow Measuring Stations

1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.

2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.14 DAMPERS

A. Manufacturers:

1. American Warming and Ventilating.
3. TAMCO.
4. United Enertech Corp.

B. Dampers: AMCA-rated, [parallel] [opposed]-blade per the design requirements; 0.108-inch-minimum thickness, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8-inches and length of 48-inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with [oil-impregnated, sintered bronze] [nylon] blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40- to 200-degrees F.

3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene or silicone.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals.

5. Jamb Seals: spring-loaded, stainless steel, only.

6. Leakage ratings or dampers shall be less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inches wg when damper is held by torque of 50 in. x lbf.; when tested according to AMCA 500D.

2.15 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."
PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of other specifications and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.

F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

G. Demolition

1. Remove controls which will not remain as part of the building automation system, including all associated wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. Demolition will include removing existing control panels, existing control devices, existing wire/cable raceways and all pneumatic control tubing and raceways. All demolished components will be properly disposed of offsite. ABANDONMENT OF ANY EXISTING CONTROL PANELS, RACEWAYS, WIRES/CABLES, PNEUMATIC TUBING/RACEWAYS IS NOT PERMITTED – THIS WILL BE STRICTLY ENFORCED.

H. Access to Site

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

I. Code Compliance

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications.

J. Cleanup

1. 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.
3.2 SYSTEM ACCEPTANCE TESTING

A. All application software will be verified and compared against the sequences of operation.

B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.3 INSTALLATION

A. Hardware Installation Practices for Wiring
   1. All controllers are to be mounted vertically and per the manufacturer’s installation documentation.
   2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
   3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
   4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
   5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
   6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
   7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
   8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
   9. Provide fire caulking at all rated penetrations.

B. Installation Practices for Field Devices
   1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Wiring, Conduit, and Cable

1. All wire will be copper and meet the minimum wire size and insulation class listed below:
   a. Power - 12 Gauge - 600 Volt
   b. Class One - 14 Gauge Std. - 600 Volt
   c. Class Two - 18 Gauge Std. - 300 Volt
   d. Class Three - 18 Gauge Std. - 300 Volt
   e. Communications - Per Mfr.

2. Power and Class One wiring may be run in the same conduit.

3. Class Two and Three wiring and communications wiring may be run in the same conduit. (Separate from Power and Class One wiring)

4. Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.

5. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

6. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

7. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

8. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

9. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.

10. Only glass fiber is acceptable, no plastic.

11. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

D. Enclosures
1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

5. All outside mounted enclosures shall meet the NEMA-4 rating.

6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

E. Identification
1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

2. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.

3. All I/O field devices (except space sensors) that are not mounted within FIP’s shall be identified with name plates.

4. All I/O field devices inside FIP’s shall be labeled.

F. Existing Controls.
1. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

G. Location
1. The location of sensors is per mechanical and architectural drawings.

2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

H. Software Installation
1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.4 TRAINING

A. The BAS system supplier shall provide both on-site and classroom training to the Owner’s representative and maintenance personnel per the following description:
B. On-site training shall consist of a minimum of (8) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
   1. System Overview
   2. System Software and Operation
   3. System access
   4. Software features overview
   5. Changing setpoints and other attributes
   6. Scheduling
   7. Editing programmed variables
   8. Displaying color graphics
   9. Running reports
  10. Workstation maintenance
  11. Viewing application programming
  12. Operational sequences including start-up, shutdown, adjusting and balancing.
  13. Equipment maintenance

3.5 CONTROL SYSTEM SWITCH-OVER

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

D. Remove controls which will not remain as part of the building automation system, including all associated wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. Demolition will include removing existing control panels, existing control devices, existing wire/cable raceways and all pneumatic control tubing and raceways. All demolished components will be properly disposed of offsite. ABANDONMENT OF ANY EXISTING CONTROL PANELS, RACEWAYS, WIRES/CABLES, PNEUMATIC TUBING/RACEWAYS IS NOT PERMITTED – THIS WILL BE STRICTLY ENFORCED

3.6 DATABASE CONFIGURATION.

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.7 POINT TO POINT CHECKOUT.

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be
filled out, dated and approved by the Project Manager for submission to the owner or owner’s representative.

3.8 WORKSTATION CHECKOUT - BY SYSTEMS INTEGRATOR

A. A checkout of all front end equipment shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner’s representative by the completion of the project.

3.9 BAS FIELD CONTROLLERS CHECKOUT – BY BAS CONTRACTOR

A. A checkout of all field devices shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner’s representative by the completion of the project.

3.10 DOCUMENTATION

A. As built software documentation will include the following:
   1. Descriptive point lists
   2. Application program listing
   3. Application programs with comments.
   4. Printouts of all reports.
   5. Alarm list.
   6. Printouts of all graphics
   7. Commissioning and System Startup
   8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

3.11 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate installed devices and instruments, whether electric or pneumatic.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer’s written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milli-ampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Flow:
a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature, CO, CO₂, static pressure, humidity, etc., set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.12 GRAPHIC DISPLAY GENERATION

A. Provide the following graphic displays as a minimum at the operator workstations, arranged in logical penetration paths:

1. Overall campus layout which shows all of the buildings on the Owner's campus.
2. Individual building layout or isometric for each building connected to the system.
3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
   a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
   b. System name.
c. Area served.
d. Present value or status of all inputs, along with present setpoint.
e. Present percent open for each damper, valve, etc. based on commanded position.
f. Reset schedule parameters for all points, where applicable.
g. Present occupancy mode.
h. Present economizer mode, where applicable.
i. Present outside air temperature.
j. Associated space conditions and setpoints, where applicable.
k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
l. Color coding to indicate normal and abnormal values, alarms, etc.

5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.

6. Sequence of operation in written (text) format for each HVAC system.

7. Overall BAS system schematic.

8. System management graphic for each network device and/or DDC panel.

9. Provide a separate page for critical alarm summary.

B. Contractor to provide graphics that are fully operational prior to commissioning.

END OF SECTION 23 09 00
SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.
   7. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Corrugated, stainless-steel tubing with associated components.
   3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   4. Pressure regulators. Indicate pressure ratings and capacities.
   5. Service meters. Indicate pressure ratings and capacities.
   6. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
   1. Shop Drawing Scale: 1/4 inch per foot <Insert scale>.
   2. Detail mounting, supports, and valve arrangements for [service meter assembly and] pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Welding certificates.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [motorized gas valves and pressure regulators] to include in emergency, operation, and maintenance manuals.
1.8 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.10 SERVICE METERS

A. Contractor shall carry an allowance for the local utility company to furnish and install gas meter assembly as determined by the construction manager upon coordination with the local utility company.

1.11 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of natural-gas service.

2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.12 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.
B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section 08 31 13 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type L
      b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
   3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K
      a. Copper fittings with long nuts.
      b. Metal-to-metal compression seal without gasket.
      c. Dryseal threads complying with ASME B1.20.3.
3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   3. Corrugated stainless-steel tubing with polymer coating.
   4. Operating-Pressure Rating: 0.5 psig.
   5. End Fittings: Zinc-coated steel.
   7. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.


C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
2.4 MANUAL GAS SHUTOFF VALVES

A. Refer to "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Brass or Bronze Ball Valves with Brass or Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      c. Conbraco Industries.
      d. Milwaukee Valve Company.
      e. Hammond Valve, Milwaukee Valve Company.
   2. Body: Forged brass or bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated brass or bronze.
   4. Stem: Brass or Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Threaded-body packnut design with adjustable-stem packing.
   8. CWP Rating: 600 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. American Production Valve
      c. Mueller Co.
      d. Xomox Corporation.
   2. Body: Cast iron, complying with ASTM A 126, Class B.
   3. Plug: Bronze or nickel-plated cast iron.
   4. Seat: Coated with thermoplastic.
   5. Stem Seal: Compatible with natural gas.
   7. Operator: Square head or lug type with tamperproof feature where indicated.
   8. Pressure Class: 125 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. Flowserve Corporation.
      c. Homestead Valve.
      d. Milliken Valve Company.
      e. Mueller Co.
   2. Body: Cast iron, complying with ASTM A 126, Class B.
   3. Plug: Bronze or nickel-plated cast iron.
   4. Seat: Coated with thermoplastic.
   5. Stem Seal: Compatible with natural gas.
   7. Operator: Square head or lug type with tamperproof feature where indicated.
   8. Pressure Class: 125 psig.
2.5 MOTORIZED GAS VALVES

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ASCO Power Technologies.
      b. Dungs, Karl.
      c. Eaton Corporation.
      d. Eclipse Innovated Thermal Technologies.
      e. Honeywell International Solutions.
      f. Johnson Controls.
   2. Body: Brass or aluminum.
   5. Normally closed.
   7. Electrical operator for actuation by appliance or fire-suppression system automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ASCO Power Technologies.
      b. Dungs, Karl.
      c. Eclipse Innovated Thermal Technologies.
      d. Goyen Valve Corp.
      e. Magnatrol Valve Corporation.
      f. Parker Hannifin Corporation.
      g. Watts.
   2. Pilot operated.
   3. Body: Brass or aluminum.
   5. Springs and Valve Trim: Stainless steel.
   6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.

2.6 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Actaris.
   b. American Meter Company.
   c. Eclipse Inovated Thermal Technologies.
   d. Fisher Control Valves and Instruments.
   e. Invensys.
   f. Itron Gas.
   g. Maxitrol Company.
   h. Richards Industries.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig
C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Canadian Meter Company.
      b. Eaton Corporation.
      c. Harper Wyman Co.
      d. Maxitrol Company.
      e. SCP.
   5. Seat Disc: Nitrile rubber.
   8. Regulator shall include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   9. Maximum Inlet Pressure: 2 psig

2.7 SERVICE METERS

   A. Contractor to coordinate installation of Natural Gas equipment with local utility company and provide terminations as required facilitating the meter assembly installation by the local utility company. See plans for specific projects requiring this service.

2.8 DIELECTRIC FITTINGS

   A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

   B. Dielectric Unions:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. A. Y. McDonald Mfg. Co.
         b. Capitol Manufacturing Company.
         c. Central Plastics Company.
         d. Hart Industrial Union.
         e. Jomar Valve.
         f. Matco-Norca.
         g. Watts.
         h. Wilkins.
i. Zurn Industries.


3. Minimum Operating-Pressure Rating: 150 psig

4. Combination fitting of copper alloy and ferrous materials.

5. Insulating materials suitable for natural gas.

6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Central Plastics Company.
   c. Metco-Norca.
   d. Watts.
   e. Wilkins.


3. Minimum Operating-Pressure Rating: 150 psig

4. Combination fitting of copper alloy and ferrous materials.

5. Insulating materials suitable for natural gas.

6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Calpico.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator.

2. Nonconducting materials for field assembly of companion flanges.

3. Minimum Operating-Pressure Rating: 150 psig


5. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.

6. Insulating materials suitable for natural gas.

7. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
2.9 SLEEVES
   A. Refer to Division 20 Section 20 05 00 “Common Work Results” for requirements.

2.10 MECHANICAL SLEEVE SEALS
   A. Refer to Division 20 Section 20 05 00 “Common Work Results” for requirements.

2.11 ESCUTCHEONS
   A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
   B. Refer to Division 20 Section 20 05 00 “Common Work Results” for requirements.

2.12 GROUT
   A. Refer to Division 20 Section 20 05 00 “Common Work Results” for requirements.

2.13 LABELING AND IDENTIFYING
   A. Refer to Division 20 “Mechanical Identification” for requirements.
   B. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

2.14 METERS AND GAGES
   A. Refer to Division 20 “Meters and Gages” for requirements.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION


B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
   3. Replace pipe having damaged PE coating with new pipe.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION


B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss,
expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:
   a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Service meter assembly will be purchased by the contractor and furnished and installed by the fuel gas company.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 20 Section 23 05 29 "Hangers and Supports."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.9 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Division 20 Section 20 05 53 "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
   c. Topcoat: Exterior alkyd enamel
   d. Color: Yellow

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:
   1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.
   3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. Two-piece, full port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
   1. Two-piece, full port, bronze ball valves with bronze trim.
   2. Cast-iron, lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Two-piece, full port, bronze ball valves with bronze trim.
   2. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full port, bronze ball valves with bronze trim.

END OF SECTION 23 11 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Copper tube and fittings.
   2. Steel pipe and fittings.
   4. Transition fittings.
   5. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   4. Piping application schedule (specific to the piping materials being used on each system).

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, 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. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Hydronic Service: Do not interrupt hydronic service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary hydronic service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of hydronic service.
   2. Do not interrupt hydronic service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 125 psig at 200 deg F.
   2. Makeup-Water Piping: 80 psig at 150 deg F.
   3. Condensate-Drain Piping: 150 deg F.
   4. Blowdown-Drain Piping: 200 deg F.
   5. Air-Vent Piping: 200 deg F.
   6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B88, Type K.

C. DWV Copper Tubing: ASTM B306, Type DWV.

D. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.


D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

A. Refer to Division 20 Section 20 05 00 “Common Work Results for Mechanical” for requirements.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Refer to “Piping System Application Schedule” in drawings.

B. Hot-water heating piping installed belowground and within slabs shall be any of the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

C. Makeup-water piping installed aboveground shall be any of the following:
   1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Condensate-Drain Piping: Type DWV drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
3.2 **PIPING INSTALLATIONS**

**A.** Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

**B.** Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

**C.** Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

**D.** Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

**E.** Install piping to permit valve servicing.

**F.** Install piping at indicated slopes.

**G.** Install piping free of sags and bends.

**H.** Install fittings for changes in direction and branch connections.

**I.** Install piping to allow application of insulation.

**J.** Select system components with pressure rating equal to or greater than system operating pressure.

**K.** Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

**L.** Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

**M.** Install piping at a uniform grade of 0.2 percent upward in direction of flow.

**N.** Reduce pipe sizes using eccentric reducer fitting installed with level side up.

**O.** Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

**P.** Install valves according to Division 20 Section 20 05 23 "General-Duty Valves for Piping."

**Q.** Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

**R.** Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

**S.** Install shutoff valve immediately upstream of each dielectric fitting.
T. Comply with requirements in Division 20 Section 20 05 16 "Expansion Fittings and Loops for Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Division 20 Section 20 05 53 "Mechanical Identification" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical".

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical".

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical".

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Division 20 Section 20 05 29 "Hangers and Supports" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 4: Maximum span, 12 feet; minimum rod size, 5/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Division 20 Section 20 05 19 "Meters and Gages."

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 2.5 hours examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
   C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
   D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
   A. Section includes special-duty valves and specialties for the following:
      1. Hydronic specialty valves.
      2. Air-control devices.
      3. Strainers.
      4. Connectors.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of the following:
      1. Include construction details and material descriptions for hydronic piping specialties.
      2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
      3. Include flow and pressure drop curves based on manufacturer’s testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.
1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig at 200 deg F.
2. Makeup-Water Piping: 80 psig at 150 deg F.
3. Condensate-Drain Piping: 150 deg F.
4. Blowdown-Drain Piping: 200 deg F.
5. Air-Vent Piping: 200 deg F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 20 Section 20 05 23 "General-Duty Valves for Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC.

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps.
   b. Bell & Gossett.
c. Flow Design.
d. Griswold Controls.
e. HCI (Hydronics Components Inc)
f. Macon Balancing.
g. Nexus Valve.
h. Taco.

2. Body: Bronze or brass body, ball with calibrated orifice or venturi.


4. Plug: Resin.

5. Seat: PTFE.

6. End Connections: Threaded or socket.


8. Handle Style: Lever, with memory stop to retain set position.


10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps.
   b. Bell & Gossett.
   c. Flow Design.
   d. Griswold Controls.
   e. HCI (Hydronics Components Inc)
   f. Macon Balancing.
   g. Nexus Valve.
   h. Taco.

2. Body: Cast-iron or steel body, globe or butterfly pattern with calibrated orifice or venturi.


5. Stem Seals: EPDM O-rings.

6. Disc: Glass and carbon-filled PTFE.

7. Seat: PTFE.

8. End Connections: Flanged or grooved.


10. Handle Style: Lever, with memory stop to retain set position.
12. Maximum Operating Temperature: 250 deg F.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol.
      b. Armstrong Pumps.
      c. Bell & Gossett.
      d. Conbraco Industries.
      e. Spence Engineering Company.
      f. Watts.
   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
   7. Low inlet-pressure check valve.
   8. Inlet Strainer: removable without system shutdown.
   10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves: ASME labeled.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol.
      b. Armstrong Pumps.
      c. Bell & Gossett.
      d. Conbraco Industries.
      e. Spence Engineering Company.
      f. Watts.
   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
8. Inlet Strainer: removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol.
      b. Armstrong Pumps.
      c. Bell & Gosset.
      d. Nexus Valve.
      e. Taco.
   2. Body: Bronze.
   3. Internal Parts: Nonferrous.
   4. Operator: Screwdriver or thumbscrew.
   5. Inlet Connection: NPS 1/2.
   7. CWP Rating: 150 psig.
   8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol.
      b. Armstrong Pumps.
      c. Bell & Gosset.
      d. Nexus Valve.
      e. Taco.
   2. Body: Bronze or cast iron.
   3. Internal Parts: Nonferrous.
   5. Inlet Connection: NPS 1/2.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. **Bladder** - Type Expansion Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Amtrol.
      b. Armstrong Pumps.
      c. Bell & Gossett.
      d. Taco.
   2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   3. **Bladder**: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

D. **In-Line Combination Air & Dirt Separators**:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Spirotherm Spirovent.
      b. Bell & Gossett CRS.
   2. Full flow coalescing type combination air eliminator and dirt separator for hydronic systems based upon system flow with pipe size.
   3. Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles. The vessel diameter and height above and below the inlet / outlet connections must be equal to the basis of design.
   4. Unit shall include internal tube elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper or stainless steel core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
   5. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
   6. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
   7. Provide removable lower head for inspection.
2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 40 mesh strainer, or perforated stainless-steel basket.

B. Basket Strainers:
   1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. T-Pattern Strainers:
   1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
   2. End Connections: Grooved ends.
   3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   4. CWP Rating: 750 psig.

D. Stainless-Steel Bellow, Flexible Connectors:
   2. End Connections: Threaded or flanged to match equipment connected.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

E. Spherical, Rubber, Flexible Connectors:
   2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

F. Expansion Fittings: Comply with requirements in Division 20 Section 20.05.16 “Expansion Fittings and Loops for HVAC Piping.”

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each hydronic terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air and dirt separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 23 21 16
SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following:
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.
   3. Automatic condensate pump units.

1.3 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump.
   1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.
   4. PERCL Index (for pumps regulated by the DOE standards).

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Mechanical Seals: One mechanical seal for each pump.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
   B. Store pumps in dry location.
   C. Retain protective covers for flanges and protective coatings during storage.
   D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
   E. Comply with pump manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS
   A. Pump Units: Factory assembled and tested.
B. Motors: Comply with requirements in Division 20 “Common Motor Requirements for Mechanical Equipment”.

C. Any pump supplied that is regulated by the Department of Energy pump standards shall be tested using the PER\textsubscript{CL} method. The pump nameplate shall bear the PER\textsubscript{CL} index. Pumps bearing only the PER\textsubscript{VL} index will not be accepted. Submittals shall clearly identify the PEI’s index and affirm that the index meets the DOE pump standards.

D. Selection:
   1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
   2. Pump speed shall be limited to 1,800 RPM except as scheduled.
   3. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
   4. Maximum impeller diameter shall not be greater than 90 percent of “cut water” diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
   5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
   6. Select pump at a point no greater than 85 percent of end of curve flow.
   7. Maximum pump suction velocity:
      a. In-line: 12 fps.
      b. End suction: 13 fps.
      c. Double suction: 15 fps.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CLOSE-COUpled, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps.
   2. Bell & Gossett.
   3. Paco Pumps.
   5. Taco.

B. Source Limitations: Obtain pumps from single source from single manufacturer.
C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

D. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and flanged connections.
   2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
   5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket. Include water slinger on shaft between motor and seal.

E. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
   1. Enclosure: Totally enclosed, fan cooled.
   2. NEMA Premium Efficient motors as defined in NEMA MG 1.
   3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   5. Variable-speed motor.
   6. Provide integral pump motor variable-speed controller.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps.
   2. Bell & Gossett.
   3. Paco Pumps.
   5. Taco.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump
and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

D. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
   2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
   4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPDM bellows and gasket.
   5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

E. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration.

F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
   1. Enclosure: Totally enclosed, fan cooled.
   2. NEMA Premium Efficient motors as defined in NEMA MG 1.
   3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   5. Variable-speed motor.
   6. Provide integral pump motor variable-speed controller.

2.5 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:
   1. Aurora Pump.
   2. Beckett Corporation.
   3. Flowserve Corporation.
   5. Little Giant Pump Co.

B. Source Limitations: Obtain pump units from single source from single manufacturer.

C. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.6 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:
   1. Angle pattern.
   2. 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
   3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch perforations and 51 percent open area.
   4. Bronze straightening vanes.
   5. Drain plug.
   6. Factory-fabricated support.

2.7 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.
   1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
   2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet MS/TP
   3. Commissioning and pump set up access to pump controls via the following:
      a. A web interface (data exchange).
      b. A user interface located on the face of speed controller to adjust modes and mode values.
      c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.
   4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:
      a. Manual (via user interface or HTML).
      b. Remote via 0 to 10 V dc.
      c. Data protocol communications with the BMS.
   5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.

7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.

8. Pump capable of being monitored continuously via integrated Internet link.

9. Integrated pump controller system to have the following features:
   a. Controller software shall be capable of sensorless control in variable-volume systems without need for pump-mounted (internal/external) or remotely mounted differential pressure sensor.
   b. Integrated Pump Controller Sensorless Control: Operates under Quadratic Pressure Control (QPC) to ensure that head reduction with reducing flow conforms to quadratic control curve.
   c. Controller:
      1) Minimum head of 40 percent of design duty head.
      2) User-adjustable control mode settings and minimum/maximum head set points using built-in programming interface.
   d. Controller Integrated Control Software:
      1) Capable of controlling pump performance for non-overloading power at every point of operation.
      2) Capable of maintaining flow rate data.

2.8 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Provide pumps so they are specified or scheduled with ECM.
   1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
   2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
   3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
   4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
   5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
   6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION
A. Comply with HI 1.4.
B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
E. Equipment Mounting:
   1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 Section 033000 "Cast-in-Place Concrete."
F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.
   1. Comply with requirements for hangers and supports specified in Division 20 Section 20 05 29 "Hangers and Supports."

3.3 ALIGNMENT
A. Engage a factory-authorized service representative to perform alignment service.
B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
D. Comply with pump and coupling manufacturers' written instructions.
E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
3.4 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check, shutoff, and throttling valves on discharge side of pumps.

F. Install Y-type strainer and suction diffuser and shutoff valve on suction side of base mounted pumps.

G. Install Y-type strainer and shut off valve on suction side of inline pumps.

H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

J. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Open discharge valve slowly.
8. Remove suction diffuser startup strainers after 48 hours of continuous circulation.

3.8 FIELD QUALITY CONTROL
   A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   B. Perform tests and inspections with the assistance of a factory-authorized service representative.
   C. Hydronic pumps will be considered defective if they do not pass tests and inspections.
   D. Prepare test and inspection reports.

3.9 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23
SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
A. Section includes pipe and fittings for LP and HP steam and condensate piping:

B. Related Requirements:
   1. Division 23 Section 23 22 16 ”Steam and Condensate Piping Specialties” for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.3 ACTION SUBMITTALS
A. Product Data: For RTRP and RTRF and adhesive.

A. Delegated-Design Submittal:
   1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
   2. Locations of pipe anchors and alignment guides and expansion joints and loops.
   3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
   4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Piping layout, 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. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to the following:
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Steam/Condensate Service: Do not interrupt steam/condensate service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary steam/condensate service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of steam/condensate service.
   2. Do not interrupt steam/condensate service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. Makeup-Water Piping: 80 psig150 deg F
   2. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless-Steel Pipe and Fittings: Schedule 10, ASTM A 312/A 312M, Grade TP316L, unless otherwise indicated; seamless pipe and ASTM A 403/A 403M, Class S, seamless fittings matching pipe thickness and grade, for welded joints.

B. All valves and accessories in the piping system shall be 316 stainless steel.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS
   A. See piping application schedule on plans.

3.2 HP STEAM PIPING APPLICATIONS
   A. See piping application schedule on plans.

3.3 ANCILLARY PIPING APPLICATIONS
   A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
   B. Vacuum-Breaker Piping: Outlet, same as service where installed.
   C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS
   A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
   B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
   C. All valves and specialties associated with clean steam and clean steam condensate shall be constructed of passivized 316 stainless steel.
3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 20 Section 20 05 23 "General-Duty Valves for Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Install strainers on their sides in the horizontal plane to prevent the collection and carry-over of condensate.

U. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 20 Section 20 05 16 "Expansion Fittings and Loops for Piping."

V. Identify piping as specified in Division 20 Section 20 05 53 "Mechanical Identification."

W. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeves specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 20 05 00 "Common Work Results for Mechanical."

3.6 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Division 23 Section 23 22 16 "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.7 HANGERS AND SUPPORTS

A. Comply with requirements in Division 20 Section 20 05 29 "Hangers and Supports" for installation of hangers and supports. Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.

C. Install hangers for steel steam supply piping with the following maximum spacing:
   1. NPS 3/4: Maximum span, 9 feet.
   2. NPS 1: Maximum span, 9 feet.
3. NPS 1-1/2: Maximum span, 12 feet.
4. NPS 2: Maximum span, 13 feet.
5. NPS 2-1/2: Maximum span, 14 feet.
6. NPS 3 and Larger: Maximum span, 15 feet.

D. Install hangers for steel steam condensate piping with the following maximum spacing:
   1. NPS 3/4: Maximum span, 7 feet.
   2. NPS 1: Maximum span, 7 feet.
   3. NPS 1-1/2: Maximum span, 9 feet.
   4. NPS 2: Maximum span, 10 feet.
   5. NPS 2-1/2: Maximum span, 11 feet.
   6. NPS 3 and Larger: Maximum span, 12 feet

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.8 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.
C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.10 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

D. Prepare test and inspection reports.

END OF SECTION 23 22 13
SECTION 23 22 16 - STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes the following piping specialties for LP and HP steam and condensate piping:
   1. Strainers.
   2. Safety valves.
   3. Pressure-reducing valves.
   4. Steam traps.
   5. Thermostatic air vents and vacuum breakers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pressure-reducing and safety valve.
   2. Steam trap.
   3. Meter.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to the following:
   1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. Makeup-Water Piping: 80 psig at 150 deg F
   2. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
   4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVE

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 20 Section 20 05 23 “General Duty Valves for Piping.”

B. Stop-Check Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A.Y. McDonald Mfg. Co.
      b. Cincinnati Valve Company.
      c. Crane.
      d. Jenkins Valves.
      e. Lunkenheimer Valves.
   2. Body and Bonnet: Malleable iron.
   4. Disc: Cylindrical with removable liner and machined seat.
   5. Stem: Brass alloy.
   6. Operator: Outside screw and yoke with cast-iron handwheel.
8. Pressure Class: 250.

C. Stainless Steel Valves:
   1. Manufacturers:
      a. NIBCO INC.
   2. Ball Valves, NPS 2 and Smaller: MSS SP-110, 600-psig minimum CWP, 2 piece, with stainless-steel body, full-port stainless-steel ball, PTFE seals, and threaded or weld ends.
   3. Ball Valves, NPS 3 and Larger: MSS SP-72, Class 150, 2 piece, with stainless-steel body, stainless-steel ball, PTFE seals, and flanged or butt-welding ends.

2.3 STRAINERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong International.
   4. Metraflex Co.
   5. Mueller Steam Specialty Co.
   6. Spirax-Sarco.
   7. Watts.
   8. Yarway.

B. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 40 mesh strainer, or perforated stainless-steel basket.
   4. Tapped blowoff plug.
   5. CWP Rating: 250-psig working steam pressure.

C. Basket Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 250-psig working steam pressure.
2.4 FLASH TANKS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cemline.
   2. Spirax-Sarco.
   3. Wessels.

B. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.5 SAFETY VALVES

A. Bronze Safety Valves: ASME labeled.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International.
      b. Kunkle Valve.
      c. Spirax Sarco.
      d. Watts.
   2. Disc Material: Forged copper alloy.
   3. End Connections: Threaded inlet and outlet.
   4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
   5. Pressure Class: 250.
   6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
   7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International.
      b. Kunkle Valve.
      c. Spirax Sarco.
      d. Watts.
   2. Disc Material: Forged copper alloy with bronze nozzle.
   3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

5. Pressure Class: 250.

6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.


2.6 PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong International.
   3. Leslie Controls.
   5. Spirax Sarco.

B. ASME labeled.

C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

E. Body: Cast iron.

F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

G. Trim: Hardened stainless steel.

H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.


2.7 NOISE SUPPRESSORS

A. Supressor shall be of the dissipative reactive type, and shall be selected to provide maximum sound attenuation for each individual application, with minimal pressure drop. Supressor shall consist of welded steel expanded outlet shell suitable for 150 psig steam maximum working pressure, containing a deflector assembly and acoustic packing of corrosion resistant material.
B. Muffling orifice shall consist of a steel plate with primary orifices to which is welded a stainless steel plate with secondary orifices.

2.8 STEAM TRAPS

A. Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International.
   b. Barnes & Jones.
   c. Hoffman Specialty.
   d. Sterling.
   e. Spirax Sarco.
   f. Watson McDaniels.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

B. Float and Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International.
   b. Barnes & Jones.
   c. Hoffman Specialty.
   d. Sterling.
   e. Spirax Sarco.
   f. Watson McDaniels.
2. Body and Bolted Cap: ASTM A 126, cast iron.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.


2.9 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International.
      b. Barnes & Jones.
      c. Hoffman Specialty.
      d. Sterling.
      e. Spirax Sarco.
      f. Watson McDaniels.
   2. Body: Cast iron, bronze, or stainless steel.
   5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
   6. Pressure Rating: 125 psig
   7. Maximum Temperature Rating: 350 deg F

B. Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong International.
      b. Hoffman Specialty.
      c. Johnson Corporation.
      d. Spirax Sarco.
   2. Body: Cast iron, bronze, or stainless steel.
   5. O-Ring Seal: EPR.
   6. Pressure Rating: 125 psig
   7. Maximum Temperature Rating: 350 deg F
2.10 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Duraflex.
      b. Flexicraft Industries.
      c. Hayspan Precision Products.
      d. Mason Industries.
      e. Metraflex Company.
      f. Twin City Hoses.
   3. End Connections: Threaded or flanged to match equipment connected.
   5. CWP Rating: 150 psig.
   6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. All valves and specialties associated with clean steam and clean steam condensate shall be constructed of passivized 316 stainless steel.

3.2 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Division 20 Section 20 05 23 "General-Duty Valves for Piping."
D. Install unions in piping, **NPS 2** > and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

E. Install flanges in piping, **NPS 2-1/2** and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

### 3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated. Provide a dirt pocket not less than 4 inches long and fitted with threaded cap on the bottom.

C. Install at all low points in steam lines, the bottom of down feed risers, and the return end of all equipment where steam is condensed, shall have traps of proper size and type.

D. Traps for draining heating and ventilating equipment, heating coils, forced flow units, water heaters, and convertors, and all equipment with 15# or less modulating steam service shall be inverted bucket traps.

E. Traps for low points in steam mains shall be high or low pressure bucket traps.

F. Steam trap of a temperature-regulated equipment must not be located at less than 14 inches below the bottom of the coil outlet, and condensate discharge from the trap must flow by gravity, without any lifts in the piping, to the condensate receiver.

G. Lifting of condensate for modulating steam service shall not be acceptable.

### 3.4 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 20 Section 20 05 19 "Meters and Gages."
F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

H. A steam noise suppressor shall be furnished and installed on each pressure reducing valve. Provide straight run of pipe on sides of PRVs, at least 10 pipe diameters to the inlet and 20 pipe diameters of expanded line size from the outlet. Avoid abrupt changes in pipe size; use eccentric reducer upstream and concentric increaser downstream of the PRVs.

3.5 SAFETY VALVE INSTALLATION

A. Install safety valves according to [ASME B31.1, "Power Piping."] [ASME B31.9, "Building Services Piping."][ASME B31.1, "Power Piping"]; and ASME B31.9, "Building Services Piping."]

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

END OF SECTION 23 22 16
SECTION 23 22 23 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and
   will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and
   will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes steam condensate pumps.

1.3 ACTION SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating
   characteristics, furnished specialties, and accessories for each type of product indicated. Indicate
   pump’s operating point on curves. Include receiver capacity and material.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other
      anchorages.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and
   maintenance manuals.
PART 2 - PRODUCTS

2.1 TWO-STAGE, CENTRIFUGAL PUMPS WITH FLOOR-MOUNTED RECEIVER

A. Manufacturers:

1. Aurora Pump.
2. Domestic Pump.
3. ITT Corporation.
5. Roth Pump Company.
8. Spirax Sarco.

B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.

1. 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. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Configuration: Duplex floor-mounted pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate with a minimum of 2 feet of NPSH.

D. Receiver:

1. Floor mounted.
2. Externally adjustable float switches.
3. Flanges for pump mounting.
4. Water-level gage and dial thermometer.
5. Pressure gage at pump discharge.
6. Bronze gate valves between receiver and pump discharge.
7. Lifting eyebolts.
8. Inlet vent and an overflow.

E. Pumps:

1. Centrifugal, two stage, close coupled.
2. Vertical design, permanently aligned, and bronze fitted.
3. Axial-flow first-stage bronze impeller.
4. Enclosed second-stage bronze impeller with replaceable bronze case rings.
5. Stainless-steel shafts.
6. Mechanical seals rated at 250 deg F.
7. Rated to operate with a minimum of 2 feet of NPSH.
8. Mounted on receiver flanges.

F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20-05-13 "Common Motor Requirements for Mechanical Equipment."
2. Enclosure: Open, dripproof.
3. Enclosure Materials: Cast aluminum
5. Efficiency: Premium efficient.

G. Control Panel:
1. Factory wired between pumps and float switches, for single external electrical connection.
2. Provide fused, control-power transformer if voltage exceeds 230 V ac.
3. NEMA 250 enclosure with hinged door and grounding lug, mounted on pump.
4. Motor controller for each pump.
5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
7. Momentary-contact "TEST" push button on cover for each pump.

2.2 PRESSURE-POWERED PUMPS

A. Manufacturers:
1. Armstrong Fluid Handling.
2. Kadant Johnson.
5. Spirax Sarco.
B. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using steam.
   1. 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. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Configuration: Duplex pump with float-operated valve control.
   1. Pump Body: ASME rated to 125 psig.
   2. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
   3. Level Gage: Glass sight gage with shutoff cocks.
   4. Valves: Manufacturer's standard check valves on inlet and outlet.
   5. Internal Parts: Stainless-steel float, springs, and actuating mechanism.

D. Receiver:
   1. Factory mounted on steel supports.
   2. Threaded piping connections.
   3. Water-level gage and dial thermometer.
   4. Pressure gage at pump discharge.
   5. Bronze fitting isolation valve between pump and receiver.
   7. Inlet vent and an overflow.
   8. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.

E. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M; Schedule 80; seamless steel.

F. Fittings: ASME B16.1, Class 125 cast iron, threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Install pumps according to HI 1.1-1.2, HI 1.3, and HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so piping is not supported by pumps.

D. Install thermometers and pressure gages.

E. Equipment Mounting:
   1. Install pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section 23 22 13 "Steam and Condensate Heating Piping" and Division 23 Section 23 22 16 "Steam and Condensate Piping Specialties."

B. Install piping adjacent to machine to allow service and maintenance.

C. Install steam supply for pressure-powered pumps as required by Division 23 Section 23 22 13 "Steam and Condensate Heating Piping."

D. Install a globe and check valve and pressure gage before inlet of each pump and a gate and check valve at pump outlet.

E. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.

F. Pipe drain to nearest floor drain for overflow and drain piping connections.

G. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

H. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Clean strainers.
3. Set steam condensate pump controls.
4. Set pump controls for automatic start, stop, and alarm operation.
5. Perform the following preventive maintenance operations and checks before starting:
   a. Set float switches to operate at proper levels.
   b. Set throttling valves on pump discharge for specified flow.
   c. Check motors for proper rotation.
   d. Test pump controls and demonstrate compliance with requirements.
   e. Replace damaged or malfunctioning pump controls and equipment.
   f. Verify that pump controls are correct for required application.
6. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

END OF SECTION 23 22 23
SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Refrigerant pipes and fittings.
   2. Refrigerant piping valves and specialties.
   3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.
   1. Include pressure drop, based on manufacturer's test data, for the following:
      a. Thermostatic expansion valves.
      b. Solenoid valves.
      c. Hot-gas bypass valves.
      d. Filter dryers.
      e. Strainers.
      f. Pressure-regulating valves.

B. Shop Drawings:
   1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
   2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference
between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

3. Show interface and spatial relationships between piping and equipment.

4. Shop Drawing Scale: 1/4 inch equals 1 foot

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE


B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.
C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Heldon Products.
      c. Parker Hannifin Corp.
      d. Paul Mueller Company.
   2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   4. Operator: Rising stem and hand wheel.
   6. End Connections: Socket, union, or flanged.
   8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Heldon Products.
      c. Parker Hannifin Corp.
d. Paul Mueller Company.

2. Body and Bonnet: Forged brass or cast bronze.

3. Packing: Molded stem, back seating, and replaceable under pressure.

4. Operator: Rising stem.


6. Seal Cap: Forged-brass or valox hex cap.

7. End Connections: Socket, union, threaded, or flanged.


9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
   e. Paul Mueller Company.

2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.


7. End Connections: Socket, union, threaded, or flanged.

8. Maximum Opening Pressure: 0.50 psig.


10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
   e. Paul Mueller Company.
   f. Refrigeration Sales.
2. **Body**: Forged brass with brass cap including key end to remove core.
3. **Core**: Removable ball-type check valve with stainless-steel spring.
4. **Seat**: Polytetrafluoroethylene.
5. **End Connections**: Copper spring.

**E. Solenoid Valves**: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
   e. Paul Mueller Company.
2. **Body and Bonnet**: Plated steel.
3. **Solenoid Tube, Plunger, Closing Spring, and Seat Orifice**: Stainless steel.
4. **Seat**: Polytetrafluoroethylene.
5. **End Connections**: Threaded.
6. **Electrical**: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [24][115][208]-V ac coil.
7. **Working Pressure Rating**: 400 psig.
8. **Maximum Operating Temperature**: 240 deg F.
9. **Manual operator**

**F. Safety Relief Valves**: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
   d. Paul Mueller Company.
2. **Body and Bonnet**: Ductile iron and steel, with neoprene O-ring seal.
3. **Piston, Closing Spring, and Seat Insert**: Stainless steel.
4. **Seat Disc**: Polytetrafluoroethylene.
5. **End Connections**: Threaded.
7. **Maximum Operating Temperature**: 240 deg F.
G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Emerson Climate Technologies.
      c. Heldon Products.
      d. Paul Mueller Company.
   2. Body, Bonnet, and Seal Cap: Forged brass or steel.
   5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   6. Suction Temperature: 40 deg F
   7. Superheat: Adjustable
   8. Reverse-flow option (for heat-pump applications).
  10. Working Pressure Rating: 450 psig

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Heldon Products.
      c. Parker Hannifin Corp.
   2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   7. Equalizer: Internal
   8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24V ac coil.
  10. Throttling Range: Maximum 5 psig.
  12. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
6. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body: Forged brass or cast bronze.
4. Screen: 100-mesh Monel.
5. End Connections: Socket or flare.
7. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in ppm.
6. End Connections: Socket or flare.
8. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Emerson Climate Technologies.
      c. Heldon Products.
      d. Parker Hannifin Corp.
   2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   5. Designed for reverse flow (for heat-pump applications).
   8. Maximum Pressure Loss: 2 psig
   9.

11. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 730.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Emerson Climate Technologies.
      c. Heldon Products.
      d. Parker Hannifin Corp.
   3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Desiccant Media: Activated [alumina] [charcoal].
   5. Designed for reverse flow (for heat-pump applications).
   8. Maximum Pressure Loss: 2 psig
10. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
5. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Heldon Products.
2. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
8. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Emerson Climate Technologies.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
5. Maximum Operating Temperature: 275 deg F.
2.4 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arkema.
   2. DuPont Fluorochemicals Div.
   4. Mexichem Flour.

B. ASHRAE 34, R-134a: Tetrafluoroethane.

C. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

D. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install **diaphragm packless** valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install **diaphragm packless** valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Section 23 09 00 Sections "Instrumentation and Control for HVAC" and Drawings for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed below ground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
   1. Shot blast the interior of piping.
   2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
   3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
   6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

S. Seal penetrations through fire and smoke barriers according to Division 07 Section 07 84 13 "Penetration Firestopping."
T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

V. Seal pipe penetrations through exterior walls according to Division 07 Section 07 92 00 "Joint Sealants" for materials and methods.

W. Identify refrigerant piping and valves according to Division 20 Section 20 05 53 "Identification for Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 20 Section 20 05 29 "Hangers and Supports for Piping and Equipment."
B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer’s written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00
SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Manual and automatic chemical-feed equipment and controls.
2. Stainless-steel pipes and fittings.
3. Chemical treatment test equipment.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACITION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.
2. Chemical test equipment.
3. Chemical material safety data sheets.
4. Centrifugal separators.
B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.

C. 1. Include plans, elevations, sections, and attachment details.
   1. Include diagrams for power and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water treatment service provider.

B. Field quality-control reports.

C. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in “Performance Requirements” Article.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ampion Corp.
   2. Anderson Chemical Company.
   3. Aqua-Chem.
5. Boland Trane Services.
7. GE Betz.
8. GE Osmonics.
12. Watcon.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hot-water heating hydronic systems, shall have the following water qualities:
   1. pH: Maintain a value within \textbf{9.0 to 10.5}
   2. "P" Alkalinity: Maintain a value within \textbf{100 to 500 ppm}.
   3. Boron: Maintain a value within \textbf{100 to 200 < ppm}.
   4. Chemical Oxygen Demand: Maintain a maximum value of \textbf{100 > ppm}.
   5. Soluble Copper: Maintain a maximum value of \textbf{0.20 ppm}.
   6. TSS: Maintain a maximum value of \textbf{10 ppm}.
   7. Ammonia: Maintain a maximum value of \textbf{20 ppm}.
   8. Free Caustic Alkalinity: Maintain a maximum value of \textbf{20 ppm}.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of \textbf{1000 organisms/mL}.
      b. Total Anaerobic Plate Count: Maintain a maximum value of \textbf{100 organisms/mL}.
      c. Nitrate Reducers: Maintain a maximum value of \textbf{100 organisms/mL}.
      d. Sulfate Reducers: Maintain a maximum value of \textbf{zero organisms/mL}.
      e. Iron Bacteria: Maintain a maximum value of \textbf{zero organisms/mL}.

D. Steam Boiler and Steam Condensate:
   1. Steam Condensate:
a. pH: Maintain a value within **7.8 to 8.4**
b. Total Alkalinity: Maintain a value within **5 to 50** ppm.
c. Chemical Oxygen Demand: Maintain a maximum value of **15** ppm.
d. Soluble Copper: Maintain a maximum value of **0.20** ppm.
e. TSS: Maintain a maximum value of **10ppm**.
f. Ammonia: Maintain a maximum value of **20** ppm.
g. Total Hardness: Maintain a maximum value of **2 ppm**.

2. Steam boiler operating at 15 psig and less shall have the following water qualities:
   a. "OH" Alkalinity: Maintain a value within **200 to 400** ppm.
   b. TSS: Maintain a value within **600 to 3000** ppm.

3. Steam boiler operating at more than 15 psig shall have the following water qualities:
   a. "OH" Alkalinity: Maintain a value within **200 to 400** ppm.
   b. TSS: Maintain a value within **600 to 1200** ppm to maximum 30 times RO water TSS.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: **5 gal.**
   2. Minimum Working Pressure: **125 psig**

B. Chemical Solution Tanks:
   1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
   2. Molded cover with recess for mounting pump.
   3. Capacity: **50 gal.**

2.4 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig Steam Working Pressure and 600-psig Cold Working Pressure ratings.
2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
   1. **Two** -station rack for closed-loop systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Bypass Feeders: Install in closed hydronic systems, including **hot-water heating**, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install water meter in makeup water supply.
   3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   5. Install a swing check on inlet after the isolation valve.

D. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:
1. Install makeup water softener.
2. Install water meter in makeup water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
   a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
4. Install test equipment and furnish test-kit to Owner.
5. Install RO unit for makeup water.
6. Install TSS controller with sensor and bleed valves.
   a. Bleed valves shall cycle to maintain maximum TSS concentration.
7. Install inhibitor injection timer with injection pumps and solution tanks.
   a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into main steam supply header.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 20 Section 20 05 00 "Common Work Results for Fire Suppression, Plumbing and Mechanical."
D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 20 Section 20 05 23 "General-Duty Valves for Piping."
E. Refer to Division 22 Section 22 11 19 "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
G. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
H. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.

4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at eight week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At eight week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:


3.5 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping heating, steam and condensate piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 00
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

E. Division 20 Section 20 59 93 “Testing, Adjusting, and Balancing” for testing, adjusting, and balancing requirements for metal ducts.

F. Division 23 Section 23 33 00 “Air Duct Accessories” for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   3. Double-wall rectangular ducts and fittings.
   4. Sheet metal materials.
   5. Duct liner.
   7. Hangers and supports.

1.3 DEFINITIONS

A. ASCE/SEI: American Society of Civil Engineers/Structural Engineers Institute.

B. ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers.


1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings are to be reviewed by the Architect prior to any fabrication.
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top and bottom of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
e. Access panels.
f. Fire alarm devices.
g. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

D. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eastern Sheet Metal (ESM).
   2. Lindab.
   4. SEMCO.
   5. Sheet Metal Connectors.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for
static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse joints in ducts larger than 60 inches in diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate round ducts 90 inches and smaller in diameter with one of the following based on indicated pressure class:
   a. Equal to or greater than +/- 4 inches.
      1) Butt Weld Seam.
      2) Spiral Seam.
   b. Equal to or less than +/- 4 inches.
      1) Spiral Seam.
      2) Lap and Rivet.
      3) Grooved Seam
   c. Exposed ductwork shall be spiral seam unless otherwise noted.
3. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. MKT Metal Manufacturing.
   3. Pro-Fab Sheet Metal.
   4. Sheet Metal Connectors.
   5. Universal Spiral Air.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.
   4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. CertainTeed Corporation.
   5. Owens Corning.
a. Maximum Thermal Conductivity:

1) Type I, Flexible: \( 0.27 \text{ Btu x in./h x sq. ft. x deg F} \) at 75 deg F mean temperature.

2) Type II, Rigid: \( 0.23 \text{ Btu x in./h x sq. ft. x deg F} \) at 75 deg F mean temperature.

6. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

7. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or “Z” profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; and when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 3 inches
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

   1. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Sealant shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
      1. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through required exit stairwells, elevator hoistways and machinery rooms, transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. [Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."]

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch w.g. and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch w.g.: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch w.g. and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch w.g.: Seal Class B.

11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch w.g.: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
      b. Supply Ducts with a Pressure Class of 2-Inch w.g. or Higher: Test representative duct sections totaling no less than 50% percent of total installed duct area for each designated pressure class.
      c. Return Ducts with a Pressure Class of 2-Inch w.g. or Higher: Test representative duct sections totaling no less than 50% percent of total installed duct area for each designated pressure class.
      d. Exhaust Ducts with a Pressure Class of 2-Inch w.g. <Insert value> or Higher: Test representative duct sections totaling no less than 50% percent of total installed duct area for each designated pressure class.
      e. Outdoor Air Ducts with a Pressure Class of 2-Inch w.g. or Higher: Test representative duct sections totaling no less than 50% percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days’ advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean **new** duct system(s) before testing, adjusting, and balancing.

B. New ducts that are protected from debris during onsite storage and after installation, and meet the requirements of the Duct System Cleanliness Test do not require additional cleaning.

C. New ducts that are utilized for temporary heating and cooling, include MERV 8 filtration on all points of intake (return air), and meet the requirements of the Duct System Cleanliness Test do not require additional cleaning.

D. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section 23 33 00 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   7. Dedicated exhaust and ventilation components and makeup air systems.
G. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.
   7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP
   A. Air Balance: Comply with requirements in Division 23 Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE
   A. See duct application schedule on plans.
   B. Intermediate Reinforcement:
      2. Aluminum Ducts: Aluminum
   C. Liner:
      1. Supply Air Ducts: Fibrous glass, Type 1 inch thick.
      2. Return Air Ducts: Fibrous glass, Type 1 inch thick.
      3. Transfer Ducts: Fibrous glass, Type 1 inch thick.
   D. Double-Wall Duct Interstitial Insulation:
      1. Supply Air Ducts: 1 inch thick.
      2. Return Air Ducts: 1 inch thick.
   E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   c. Velocity 1500 fpm or Higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to-Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible,” Figure 4-6, “Branch Connection.”
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible,” Figure 3-5, “90 Degree Tees and Laterals,” and Figure 3-6, “Conical Tees.” Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

E. Division 23 Section 23 37 23 “HVAC Gravity Ventilators” for roof-mounted ventilator caps.

F. Division 28 Section 28 31 11 “Digital, Addressable Fire-Alarm System” for duct-mounted fire and smoke detectors.

1.2 SUMMARY

A. Section Includes:
   1. Backdraft dampers.
   2. Barometric relief dampers.
   4. Control dampers.
   5. Fire dampers.
   7. Combination fire and smoke dampers.
   8. Flange connectors.
  10. Remote damper operators.
  11. Duct-mounted access doors.
  12. Duct access panel assemblies
  13. Flexible connectors.
  14. Flexible ducts.
  15. Duct accessory hardware.
1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      c. Control damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.
PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


B. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with AMCA 500-D testing for damper rating.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: [G90] [G60].
   2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance.
   2. American Warming and Ventilating.
   3. Cesco Products.
   4. Duro Dyne.
   5. Greenheck Fan Corporation.
   7. Pottorff.
8. Ruskin Company.
9. SEMCO.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm

D. Maximum System Pressure: 3-inch wg.

E. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch width, with sealed edges.

G. Blade Action: Parallel.

H. Tie Bars and Brackets: Galvanized steel.

I. Return Spring: Adjustable tension.

J. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Screen Mounting: Front mounted in sleeve.
      a. Sleeve Thickness: 20-gage minimum.
      b. Sleeve Length: 6 inches minimum.
   6. Screen Mounting: Rear mounted.
   7. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance.
   2. American Warming and Ventilating.
   3. Flexmaster U.S.A.
   6. METALAIRE.
8. Pottorff.

B. Low-Leakage, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance.
      b. American Warming and Ventilating.
      c. Flexmaster U.S.A.
      d. Greenheck Fan Corporation.
      e. METALAIRE.
      f. Nailor Industries.
      g. Ruskin Company.
   2. Low-leakage rating and bearing AMCA’s Certified Ratings Seal for both air performance and air leakage.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat shaped.
      b. 0.094-inch thick, galvanized sheet steel.
      c. Mitered and welded corners.
      d. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized roll-formed steel, 0.064 inch thick.
   6. Blade Axles: Galvanized steel
   7. Bearings:
      a. Oil-impregnated bronze.
      b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Jamb Seals: Cambered
   9. Accessories:
      a. Include locking device with 2” stand-off bracket to hold single-blade dampers in a fixed position without vibration.
C. Jackshaft:
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating.
   2. Cesco Products.
   3. Duro Dyne.
   6. METALAIRE.
   8. Ruskin Company.
   10. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
   1. Hat shaped.
   2. 0.094-inch- thick, galvanized sheet steel
   3. Mitered and welded corners.

D. Blades:
   1. Multiple blade with maximum blade width of 6 inches
   2. Parallel- and opposed blade design.

E. Blade Axles: 1/2-inch- diameter; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
   1. 
   2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Inc.
   2. Cesco Products.
   5. METALAIRE.
   7. Ruskin Company.
   8. Vent Products Company,

B. Type: Dynamic rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch w.g. static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.


2.7 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance.
   2. Cesco Products.
   5. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel, with welded corners and mounting flange.
   A. Blades: Roll-formed, horizontal, interlocking, 0.063-inch thick, galvanized sheet steel.

B. Leakage: Class I.

C. Rated pressure and velocity to exceed design airflow conditions.

D. Mounting Sleeve: Factory-installed, 0.05-inch thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

E. Damper Motors: Two-position action.

F. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

G. Accessories:
1. Auxiliary switches for position indication.
2. Test and reset switches, remote mounted.

2.8 FLANGE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries.
   2. Elgen.
   3. Nexus PDQ.

B. Description: factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.9 TURNING VANES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries.
   2. Duro Dyne.
   3. METALAIRE.
   4. SEMCO.
   5. Ward Industries.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 36 inches wide and double wall for larger dimensions.

2.10 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Metropolitan Air Technology (MAT).
   2. Potterff.
   3. Ventfabrics.
   4. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass

D. Cable: Stainless steel

E. Wall-Box Mounting: Recessed, 2 inches deep.

F. Wall-Box Cover-Plate Material: Painted Steel

2.11 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating.
   2. Cesco Products.
   3. Ductmate Industries.
   4. Flexmaster U.S.A.
   5. Greenheck Fan Corporation.
   8. Potterff.
   9. Ruskin.
   10. Ventfabrics.


1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries.
   2. Duro Dyne.
   3. Ventfabs.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip [3-1/2 inches] [5-3/4 inches] wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

   1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.
4. Service Temperature: Minus 67 to plus 500 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.13 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Atco.
   2. Flexmaster U.S.A.
   3. Hart & Cooley
   4. Thermaflex.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; vapor-barrier film.
   1. Pressure Rating: 10-inch w.g. positive and 1.0-inch w.g. negative.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Insulated, Flexible Duct: UL 181, Class 1, polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation vapor-barrier film.
   1. Pressure Rating: 4-inch w.g. positive and 0.5-inch w.g. negative.
   3. Temperature Range: Minus 20 to plus 175 deg F.
   4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.
D. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with zinc-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible” for metal ducts and in NAIMA AH116, “Fibrous Glass Duct Construction Standards,” for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft, control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.
   3. Install stainless steel volume dampers in stainless steel ducts and PVC coated steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

K. Label access doors according to Division 20 Section 20 05 53 "Mechanical Identification" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts directly

O. Connect flexible ducts to metal ducts with [adhesive plus sheet metal screws].

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00
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SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Ceiling-mounting ventilators.
   3. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations
B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.
1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate sizes and locations of concrete bases with actual equipment provided.
C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Aerovent.
   3. Breidert Air Products.
   5. Greenheck Fan Corporation.
   7. Loren Cook Company.
   8. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

A. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   5. Fan and motor isolated from exhaust airstream.

B. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.


4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

C. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: **Self-flashing without a cant strip, with mounting flange.**

2. Overall Height: **18 inches.**


2.2 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Breidert Air Products.

2. Broan-NuTone.

3. Carnes Company.


5. Loren Cook Company.

6. PennBarry.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: **Aluminum**, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
6. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Carnes Company.
   5. Loren Cook Company.
   6. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.
   4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section 07 72 00 "Roof Accessories" for installation of roof curbs.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and **elastomeric hangers** having a static deflection of **1 inch**

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section 23 33 00 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature-control operators.
  11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 20 Section 20 05 93 “Testing, Adjusting, and Balancing” for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.
END OF SECTION 23 34 23
SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following:
   1. Single-duct air terminal units.
   2. Casing liner.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment.
1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 01 Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. Instructions for resetting minimum and maximum air volumes.
      b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. Anemostat/Johnson Controls.
5. Titus.
6. Trane.
7. Tuttle & Bailey.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: **0.034-inch** thick galvanized steel, single wall.
   1. Casing Liner: Comply with requirements in “Casing Liner” Article for fibrous-glass duct liner.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   6. Provide mounting brackets on casing.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
   3. The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.

E. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

F. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 “Instrumentation and Control for HVAC.”

G. Control devices shall be compatible with temperature controls system specified in Division 23 Section 23 09 00 “Instrument and Control for HVAC.”

2.3 CASING LINER

A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Minimum Thickness: **3/4 inch**
      a. Maximum Thermal Conductivity:
         1) Type I, Flexible: **0.27 Btu x in./h x sq. ft. x deg F** at 75 deg F mean temperature.
2) Type II, Rigid: \(0.23 \text{ Btu} \times \text{in./h} \times \text{sq. ft.} \times \text{deg F} \) at 75 deg F mean temperature.

2. **Antimicrobial Erosion-Resistant Coating:** Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. **Water-Based Liner Adhesive:** Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   a. Adhesive VOC Content: 80 g/L or less.
   b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health’s "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 **SOURCE QUALITY CONTROL**

A. **Factory Tests:** Test assembled air terminal units according to AHRI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and AHRI certification seal.

PART 3 - EXECUTION

3.1 **HANGER AND SUPPORT INSTALLATION**

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Division 20 Section 20 05 29 "Hangers and Supports."

B. **Building Attachments:** Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. **Hangers Exposed to View:** Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
3.2 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.3 CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Comply with requirements in Division 23 Section 23 31 13 "Metal Ducts" for connecting ducts to air terminal units.

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section 23 33 00 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 20 Section 20 05 53 "Mechanical Identification" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.
C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.
E. Division 23 Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUMMARY
A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Perforated diffusers.
   3. Louver face diffusers.
   4. Linear slot diffusers.
   5. Drum louvers.
   6. Linear bar grilles.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, fire alarm devices, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products.
      b. Carnes Company.
      c. Hart & Cooley.
      d. METALAIRE.
      e. Nailor Industries.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   2. See plans for all properties and characteristics.

B. Perforated Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products.
      b. Carnes Company.
      c. Hart & Cooley.
      d. METALAIRE.
      e. Nailor Industries.
      f. Price Industries.
      g. Titus.
      h. Tuttle & Bailey.
   2. Devices shall be specifically designed for variable-air-volume flows.
3. See plans for all properties and characteristics.

C. Louver Face Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
   c. Hart & Cooley.
   d. METALAIRE.
   e. Nailor Industries.
   f. Price Industries.
   g. Titus.
   h. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. See plans for all properties and characteristics.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
   c. Hart & Cooley.
   d. METALAIRE.
   e. Nailor Industries.
   f. Price Industries.
   g. Titus.
   h. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. See plans for all properties and characteristics.

B. Linear Slot Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
c. Hart & Cooley.
d. METALAIRE.
e. Nailor Industries.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. See plans for all properties and characteristics.

2.3 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
   c. Hart & Cooley.
   d. Krueger.
   e. METALAIRE.
   f. Nailor Industries.
   g. Price Industries.
   h. Titus.
   i. Tuttle & Bailey.
2. See plans for all properties and characteristics.

2.4 REGISTERS AND GRILLES

A. Linear Bar Grille
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
   c. Hart & Cooley.
   d. Krueger.
   e. Nailor Industries.
   f. Price Industries.
   g. Titus.
2. See plans for all properties and characteristics.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Support flexible duct connectors at connection to air diffusion devices with “FLEXFLOW ELBOW” elastomeric duct elbow support as manufactured by Thermaflex or approved equal.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
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SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
   C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.
   D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors' participation in the commissioning process.

1.2 SUMMARY
   A. Section Includes:
      1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS
   A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
   B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
      1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.5 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use screws for exposed fasteners unless otherwise indicated.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Aerovent.
   3. Carnes Company.
   5. Loren Cook Company.
   6. PennBarry.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

C. Materials: Galvanized-steel sheet, minimum 0.064-inch- thick base and 0.040-inch- thick hood; suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 18 inches.

E. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

F. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
   2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
   3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
a. Color and Gloss: As selected by Architect from manufacturer’s full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section 07 92 00 "Joint Sealants" for sealants applied during installation.

E. Label gravity ventilators according to requirements specified in Division 20 Section 20 05 53 "Mechanical Identification."

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Division 23 Section 23 31 13 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 37 23
SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents
2. Field-fabricated metal breechings and chimneys.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Special gas vents.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Special warranty specified in this Section.
1.5 QUALITY ASSURANCE
   A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
   C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.6 COORDINATION
   A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section 07 72 00 "Roof Accessories."

1.7 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
      1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Heat-Fab.
      2. Metal-Fab.
      4. Schebler Co.
      5. Z-Flex.
   B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.
   C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.
   D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
   E. Outer Jacket: Aluminized steel.
F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.

2.2 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 5/16 inch in diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain. Slope grease ducts at a minimum of 2% back in direction of the grease hood or toward an approved grease reservoir. Where horizontal ducts exceed 75 feet in length, the slope shall not be less than 8.3%.

E. Lap joints in direction of flow.

F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.
3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 00
SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and sections, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

C. Field quality-control reports.
D. Efficiency Data Points: Data shall be submitted per ASHRAE 155 Method of Testing for Rating Commercial Space Heating Boiler Systems. This data shall cover steady state thermal efficiency, part load efficiency, and idling energy input rate. Efficiency data not supported by a third party published test standard shall not be permitted.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.

1. Warranty Period for Fire-Tube Condensing Boilers:
   a. Heat Exchanger and Tank: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements" and other requirements in Chapter 6.

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 431, Subpart E, Appendix N.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AERCO Benchmark.
2. Cleaver Brooks Clearfire-CE.
3. Lochinvar Crest.
4. Lochinvar FTXL.
5. Patterson Kelly Sonic.
B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

C. Primary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.

D. Secondary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.

E. Combustion Chamber and Flue Pipes: Corrosion-resistant stainless steel.

F. Pressure Vessel: Carbon steel with welded heads and tube connections.

G. Burner: Natural gas, forced draft.

H. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
   1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 "Common Motor Requirements for Mechanical Equipment."
      a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

I. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

J. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

K. Casing:
   1. Jacket: Factory painted sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   3. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.

L. Capacities and characteristics are listed in the mechanical schedule drawing.

2.3  TRIM FOR HOT-WATER BOILERS

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Aquastat Controllers: Operating, firing rate, and high limit with manual reset.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. High and low gas-pressure switches.
F. Alarm bell with silence switch.

G. Boiler Air Vent: **Automatic**.


### 2.4 CONTROLS

A. Refer to Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:
   1. Control transformer.
   2. Set-Point Adjust: Set points shall be adjustable.
   3. Electric, factory-fabricated and factory-installed panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. Reset information to be provided by the building control system or a outside-air temperature sensor provided by the boiler manufacturer. Coordinate requirements with Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
      a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
   2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
   4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   1. Hardwired Points:
      a. Monitoring: On/off status, common trouble alarm, low water level alarm.
      b. Control: On/off operation, hot water supply temperature set-point adjustment.
   2. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. All monitoring and control features, which are available at the local boiler control panel, shall also be available at the remote operator workstation through the building automation system.
2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to non-fused disconnect switch
   5. Provide branch power circuit to each motor and to controls
   6. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Refer to Division 23 Section 23 51 00 "Breechings, Chimneys, and Stacks."

2.7 CONDENSATE-NEUTRALIZATION UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Neutra-Safe Corporation.
   2. SFA Saniflo USA.

B. Description: Factory-fabricated and -assembled condensate-neutralizing capsule or tank assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

C. Capsule or Tank features:
   1. All corrosion-resistant material.
   2. Suitable for use on all natural gas and propane boilers.
   3. Includes initial charge of neutralizing agent.
   4. Neutralizing agent to be easily replaceable when exhausted.
   5. Inlet and outlet pipe connections.

D. Capsule Configuration:
   1. Low-profile design for applications where boiler condensate drain is close to the floor.
   2. Easily removed and opened for neutralizing agent replacement.
E. Tank Configuration:
   1. Utilized where boiler is elevated or where tank is installed in a pit with tank top flush with floor.
   2. Top easily removed for neutralizing agent replacement.
   3. Internal baffles to channel flow for complete neutralization.
   4. Integral bypass to prevent condensate backflow into appliance.
   5. Multiple units may be used for larger capacity.

2.8 SOURCE QUALITY CONTROL

   A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h (117 kW) for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

   B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

   C. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

   D. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
      1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

   B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

   A. Equipment Mounting:
      1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."
B. Install gas-fired boilers according to NFPA 54.
C. Assemble and install boiler trim.
D. Install electrical devices furnished with boiler but not specified to be factory mounted.
E. Install control wiring to field-mounted electrical devices.

3.3 PIPING CONNECTIONS
A. Comply with requirements for hydronic piping specified in Division 23 Section 232113 "Hydronic Piping."
B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
C. Drawings indicate general arrangement of piping, fittings, and specialties.
D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.
E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow. Include any vent drains.
F. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
G. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve, and union or flange at each connection.
H. Install piping from safety relief valves to nearest floor drain.

3.4 DUCT CONNECTIONS
A. Boiler Venting:
   1. Comply with all boiler manufacturer's installation instructions.
   2. Refer to Division 23 Section 23 51 00 "Breechings, Chimneys, and Stacks."

3.5 ELECTRICAL CONNECTIONS
A. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 Section 260523 “Control-Voltage Electrical Power Cables.”

3.7 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer’s written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Boiler will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section 01 79 00 "Demonstration and Training." Video record the training sessions and provide electronic copy to Owner.
   1. Instructor shall be factory trained and certified.
   2. Provide not less than two hours of training.
   3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
   4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 23 52 16
SECTION 23 52 39 - FIRE-TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes horizontal, packaged, factory-fabricated and -assembled fire-tube boilers, trim, and accessories for generating steam.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.

2. Rated capacities, operating characteristics, and furnished specialties and accessories.

3. Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.

4. Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.

5. Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.

6. Calculations showing predicted surface temperature of boiler jacket with basis indicated.

7. Force and moment capacity of each piping and flue connection.

8. Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.

9. Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.

10. Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.
11. Pressure rating, size, and materials of construction for boiler fuel train components including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.

12. Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.

13. Product data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
   4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to 1/4" per foot scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:
   1. Column grids, beams, columns, and concrete housekeeping pads.
   2. Room layout with walls, floors, and roofs, including each room name and number.
   3. Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems, and plumbing systems.

B. Installation instructions.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

F. Other Informational Submittals:
   1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
   2. Startup service reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.
B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:
   1. A tool kit specially designed by boiler manufacturer for use in servicing boiler(s) furnished.
   2. Special tools required to service boiler components not readily available to Owner service personnel in performing routine maintenance.
   3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as “Boiler Tool Kit.” Text size shall be at least 1 inch high.
   4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 0.5 in. high.

B. Touch-up Paint: 32 oz. container of paint used for finish coat. Label on outside of container shall have a detailed description of paint to allow for procurement of a matching paint in the future.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.

B. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.

C. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

D. Package boiler for export shipping in totally enclosed crate with bagging.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace front- and rear-door refractories and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.
   1. Packaged Boilers shall be warranted from date of start-up for 5 years.
   2. Heat Exchangers
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fuel-to-steam efficiency indicated shall be based on the following:
   1. ASME Performance Test Code (PTC) 4, Input-Output method.
   2. Test Operating Conditions:
      a. Percent Excess Air in Exhaust Flue Gas: 15.

B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient air quality standards in governing jurisdiction and indicated values.
   1. Carbon monoxide:
      a. 50 parts per million at any point from 100 percent to 50 percent fire.
      b. 150 parts per million at any point below 50 percent fire.
   2. Nitrogen compounds: 20 parts per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
   3. Sulfur compounds: One part per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
   4. Hydrocarbon and Volatile Organic Compounds: 10 parts per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
   5. Particulate Matter: 0.01 lb/MMBtu.
   6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.

C. Multiple Boiler Operation: Equip individual boilers in multiple boiler applications with integral controls (retrofit existing boiler) to provide multiple boiler operation for optimum system performance, energy efficiency, and the following:
   1. Operate boiler system as described in sequence of operation.
   2. Operate multiple boilers hot to minimize disruption of service in the event of single boiler failure.
   3. Configure controls so any boiler can be taken out of service with power disconnected and not impact multiple boiler operation.

D. Sound: Boiler sound level, measured according to parameters defined in ABMA publication "Boiler 304 Measurement of Sound from Steam Generators" shall not exceed 70 dBA.

E. Steam Quality: 99.5% at maximum firing regardless of operating pressure

F. Natural Gas Efficiency: 85% for 15# steam, Efficiency rating shall account for radiation and convection losses.

G. Radiation losses: Less than 0.5% of the rated input at maximum firing

H. Operation Following Loss of Normal Power:
   1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

I. 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.

J. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

K. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

L. ISO 14000 Certification: Boiler manufacturer to provide certification stating that it has self-certified its company to ISO 14000.

M. UL Compliance: Test Boilers for compliance with [UL 726 and UL 795]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.2 HORIZONTAL FIRE-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Bryan Boilers

B. Base:
   1. Factory-mounted pressure vessel and other boiler components on steel saddles or supports that are fastened securely to a structural steel base that is constructed to make a complete self-supported unit requiring only a flat level surface for support.
   2. Base included with attachments if required to secure boiler to structure.
   3. Manufacturer's standard provisions for lifting include the following.
      a. Designed for handling and installation conditions encountered.
      b. Sufficient to carry total weight of fully assembled boiler with a safety factor of 1.2.

C. Shell:
   1. The vessel must be subjected to the required inspections of the Code conducted by an independent third-party inspector. A signed inspection sheet shall be provided to the purchaser and the appropriate ASME symbol shall be affixed or stamped onto the boiler.
   2. Horizontal, cylindrical, steel pressure vessel of size to satisfy performance requirements indicated.
   3. Manholes and Handholes:
      a. Manhole for waterside inspection and access.
b. Handholes at front and rear of boiler for waterside inspections.
c. According to ASME Boiler and Pressure Vessel Code.

4. Steam Boilers:
   a. Connections for steam supply, feedwater, level controls, and chemical treatment.
   b. Baffle in shell below steam outlet to provide dry steam with no water carry over.
   c. Bottom and surface blowdown connections.
   d. Connections with safety relief valve(s).
   e. Connections for other trim indicated.

D. Boiler Shell Tappings/Openings
   1. The following boiler vessel tappings/openings shall be furnished:
      a. Steam supply by NPT connection for high-pressure steam or flanged for low pressure steam.
      b. Bottom blowdown/drain.
      c. Feedwater Make-up.
      d. Surface blowoff.
      e. Chemical Feed.
      f. High Water Level Overflow Drain to discharge water in the boiler if water level reaches an unacceptable level.
      g. Safety Relief Valve(s).

E. Steam Boiler Trim
   1. Water Column
      a. A water column shall be furnished complete with gauge glass and water column blowdown valve.
      b. Feedwater Pump Control – shall be integral with the water column via probe control device and electronics for on/off pump operation.
      c. Low Water Cutoff – shall be integral with the water column via probe control device and solid-state electronics mounted and wired in the control panel.
      d. An Auxiliary Low Water Cutoff shall be provided. It shall be located on the top centerline of the boiler using an internal probe and shall be of the manual reset design.
      e. For safety steam pressure lockout, a high limit pressure control, manual reset shall be provided. The device shall be mercury free.
      f. To provide steam demand tracking a steam pressure transmitter shall be provided that provides an input signal for burner positioning in accordance to steam demand.
      g. A 3" Steam Pressure Gauge shall be piped onto the trim piping, including an inspector’s test.
      h. In accordance with the A.S.M.E. Code an approved A.S.M.E. rated and stamped safety valve shall be provided and set at 15#.

F. Furnace:
1. Welded cylindrical steel chamber that is welded to steel tube sheets.
2. Arranged to provide uniform heat distribution under all firing conditions with no flame impingement on any refractory-covered or waterbacked surface.
3. Surrounded by water without interfering with natural circulation of water within shell.
4. Positioned from shell to inhibit unequal thermal stresses during operation.

G. Fire Tubes:
1. Steel, seamless or resistance welded.
2. Fitted in accurately sized holes in tube sheets and rolled or welded in place.
3. Aligned to prevent noticeable deformation with undue stress when boiler is put in service.
4. Tube and tube sheet assembly shall be water- and gastight.
5. Arranged not to interfere with natural circulation of water in shell or to inhibit cleaning and flushing of water sides.
6. Readily removable from one end of boiler.
7. Provided without spinners, turbulators, and other inserted devices.

H. Flue:
1. Flanged connection located along top centerline of boiler and capable of supporting a field-installed flue stack with a weight of at least 2000 lbs.
2. Equip boiler flue with bimetal thermometer in a stainless-steel case, with angle position adjustment and nominal 5-inch diameter face having a graduated scale and range of approximately 1.5 times the outlet temperature. Mount thermometer in a Type 316 stainless-steel thermowell that is located in a visible location to indicate flue-gas temperature.

I. Front and Rear Doors:
1. Hinged, sealed with heat-resistant gaskets and fastened with lugs and cap screws.
2. Designed so tube sheets and flues are fully accessible for inspection or cleaning when doors are open without the need to disconnect burner, blower, and fuel piping.
3. Include observation ports in doors at both ends of boiler for inspection of flame conditions.
4. Door refractory and insulation shall be accessible for inspection and maintenance.
5. Reinforce doors of dryback boilers to limit deflection due to thermal stresses and burner combustion pulsations to prevent progressive cracking and loosening of refractory.

J. Refractories:
1. Refractories retained shall withstand temperature occurring under maximum load conditions.
2. Formed or cast-in sections shall be easily replaceable through factory openings.
3. Secure refractory sections in position to withstand vibration and shock occurring during shipment, and to withstand burner combustion pulsations.
4. Where used for the burner combustion ring and rear or target baffle, refractories shall have a parametric cone equivalent of not less than 33.
5. Provide refractory for doors and end covers exposed to temperatures of 600 deg F and higher.

K. Insulation:
   1. Minimum 2-inch-thick, mineral-fiber insulation surrounding the boiler shell and secured in place to prevent sagging or displacement.
   2. Insulation of sufficient density or attached with reinforcement to prevent permanent deformation of protective jacket.

L. Jacket: Galvanized sheet metal, with factory-applied protective finish.
   1. Nominal Thickness: Not less than 0.030 in..
   2. Preformed shape to follow a smooth and uniform contour of pressure vessel and encapsulating insulation.
   3. Consisting of multiple removable sections attached with corrosion-resistant screw-fasteners to facilitate removal and replacement multiple times.
   4. Painted after assembly.

2.3 BURNER AND BURNER CONTROLS

A. Mode of Operation - To minimize short cycling and provide highest efficiency the burner for the specified boiler shall be of the electronic modulation with a turndown ratio of 10:1. On/off or low/high burner operation shall not be accepted.

B. The burner assembly shall be enclosed in a NEMA 1 type enclosure. A lift off top cover shall be provided to gain access to the burner and controls.

C. Design - The burner design shall be of the linkage-less self-regulating venturi premix technology wherein the fuel and air are mixed in the combustion air fan housing assembly prior to entering the burner canister. Separately driven linkage or servo motor driven fuel valves shall not be permitted.
   1. Fan housing shall utilize non-sparking material and shall be approved for premix operation.
   2. The combustion air fan shall be driven by a variable speed motor which shall react to output demand requirements via the demand control providing true linear PID modulation. Motor shall be a high efficiency ECM type with integral variable speed drive electronics. Continuous speed synchronous motors will not be acceptable.

D. Ignition of the fuel shall be of the direct spark design; separate pilot gas train is not required (up to 60 bhp). Pilot ignition system shall be implemented on boilers larger than 60 bhp. Dual ignition electrodes shall be used for the spark generated from the panel mounted ignition transformer.

E. Combustion shall take place on the surface of the burner canister. The canister shall be constructed of Fecralloy material and stainless steel and shall be warrantied for five years against failure from defects or poor workmanship.

F. Air Filter - shall be fitted to the intake air venturi to filter the incoming air supply when using boiler room air. The air filter shall be designed to be easily cleaned and re-used.
G. **Fuel** - The burner shall be designed for operation with natural gas or LP gas. Gas Train, shall be located at the front of the burner and along the left side of the boiler. In accordance with UL/cUL and ASME CSD-1, the following components shall be furnished:

1. Single body dual solenoid safety shutoff valve incorporating the following:
   a. The valve shall be a 1:1 ratio valve with an integral trim regulator and shall operate in relation to the fan speed. An air sensing line shall be connected from the air inlet venturi (mounted to the fan motor) and to the gas valve for control of gas input.
   b. As fan speed increases a negative pressure will be applied to the valve, allowing the valve to open further, permitting more fuel to flow into the venturi for mixing. As fan speed is reduced, fuel input shall be reduced accordingly. Air shall always lead fuel from low to high or high to low.

2. Manual fuel shutoff valve – shall be located downstream of the gas valve and used for CSD-1 leak testing.

3. Gas Pressure Interlocks - one shall be provided for sensing high gas pressure, and one provided to sense low gas pressure. Each control shall be of the manual reset type.

4. Gas Pressure Regulator - shall be provided upstream of the gas valve to provide regulated pressure to the gas train from the gas supply. This regulator shall be suitable for a maximum of 1 psig gas pressure. If gas pressure exceeds 1 psig, a gas pressure relief valve shall be furnished and upstream pressure regulator that is of the full lockup type.

5. Manual Shutoff Valves - shall be provided upstream of the gas regulator to manually close off the gas supply when servicing the gas train or isolating the boiler. A shutoff valve shall be provided at the burner for tightness checking of the gas valve.

6. Combustion Air Proving Switch shall be provided to prove, prior to modulation that the fan is operating properly.

H. **Flame Safety**

1. Flame Sensing shall be accomplished with UV sensing or a flame rod mounted in the burner mounting plate, designed for easy removal for inspection or replacement.

2.4 **CONTROLS**

A. The Boiler shall include a Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point switches. It shall be mounted at the front of the boiler panel for easy access and viewing. The controller combines flame supervision, burner sequencing, modulating control, and multiple boiler lead-lag in one integrated microprocessor. The control shall include a color touchscreen operator interface with all indication, diagnostics, alarm, and parameterization in English text.

B. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:

1. Burner sequencing with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.

2. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent six faults. The control shall be connected to a keyboard display module that will retrieve this information.

3. Safety Shutdown with display of error.
4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
5. Gas pressure supervision, high and low.
7. The steam pressure and set-point pressure shall be displayed at all times on color touchscreen operator interface. Modulation Output shall be continuous a PID control via PWM or 4–20 mA current.

C. All parameter input control set-points shall be factory configured with jobsite conditions configured at the time of initial jobsite operation.

D. Demand switch.

E. Provide terminals for control interface wiring, customer connections, and connections for incoming power.

F. Install solid state circuit boards for water level controls.

G. Selectable Options:
   1. Alarm Light Package to provide indication of Low Water, Flame Failure, Load Demand, Fuel Valve On, including a horn with silence switch for alarm conditions.

H. Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Manufacturer to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.

2.5 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   1. Enclosure: NEMA 250, Type 4
      a. Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
      b. Mounted on boiler assembly at a location convenient to operator.
      c. Enclosure shall have hinged full-size door with key lock with common key for all locks.

   2. Wiring shall be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
   3. Install wiring outside of an enclosure in a metal raceway. Make final connections to motors using flexible conduit. Provide watertight installation for applications exposed to moisture.
   4. Field power interface shall be to nonfused disconnect switch. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.
   5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

7. Provide transformer with fuses and power wiring to power a 20-A 120-V duplex receptacle mounted in each boiler control panel for use in connecting analytical and testing equipment.

2.6 FINISH

A. General:
   1. Paint boiler, using manufacturer's standard procedures, except comply with requirements indicated.
   2. Miscellaneous surfaces shall be finished to match continuous surfaces.
   3. Manufacturer shall field touch up or entirely repaint surface finishes, which were damaged during shipment, to original condition, using original materials and methods.
   4. Paint shall be suitable for temperatures encountered on painted surfaces.
   5. Requirements indicate minimum quality level. Provide more robust paint system if required to comply with other requirements indicated.

B. Preparation:
   1. Follow paint manufacturer's published preparation and application instructions.
   2. When paint manufacturer’s recommended preparation requirements differ from those specified, use more stringent requirements.
   3. Structural steel with visible corrosion shall be sandblasted according to SSPC SP-6 or SSPC SP-10 before applying primer and paint.
   4. Before application of a primer and a top coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner according to SSPC SP-1.
   5. Treat galvanized-steel surfaces that cannot be procured with a phosphatized finish with a phosphate rinse to ensure proper paint adhesion.

C. Primer:
   1. Rust-inhibiting type with a minimum dry film thickness of 2 mils.
   2. Provide multiple passes if required to prevent runs.
   3. Select a primer that is compatible with substrate and finish coat.

D. Finish Coat:
   1. Finish coat shall be alkyd enamel
   2. Use dry film thickness recommended by paint manufacturer, but not less than 2 mils. Provide multiple passes if required to prevent runs.

E. Paint the following surfaces with both a primer and finish coat:
   1. Base and miscellaneous supports that are not hot dip galvanized.
   2. Carbon steel that is not galvanized.
   3. Exterior surfaces of unit exposed to view.
4. Piping and trim.
   F. Do not paint aluminum or stainless steel.

2.7 SOURCE QUALITY CONTROL
   A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
   B. Burner and Hydrostatic Test:
      1. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.
      2. Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
      1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.
   B. Examine areas where boilers will be installed for suitable conditions.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION
   A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   B. Equipment Mounting:
      1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
   C. Install gas-fired boilers according to NFPA 54.
   D. Assemble and install boiler trim, components, and accessories that are not factory installed.
   E. Install control and electrical devices furnished with boiler that are not factory mounted.
   F. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.
**3.3 PIPING CONNECTIONS**

**A.** Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

**B.** Where installing piping adjacent to boiler(s), allow space for service and maintenance.

**C.** Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

**D.** Connect steam and condensate piping to supply-, return-, and blowdown-boiler connections with union or flange at each connection. Provide each connection with shutoff valve if shutoff valves are not factory furnished with boiler trim. Retain first paragraph below if retaining "Flue-Gas Economizer" Article in Part 2.

**E.** Connect feedwater piping to inlet- and discharge-flue-gas economizer connections with union or flange at each connection. Provide each connection with shutoff valve and other accessories indicated and recommended by manufacturer.

**F.** Install piping from safety relief valves to nearest floor drain.

**G.** Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.

**H.** Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

**I.** Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled nonpotable domestic cold water source to cool hot equipment drains

**J.** Connect chemical-treatment piping to each boiler chemical-treatment connection with check valve and isolation valve.

**G.** Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests. Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.

**H.** Protect boiler fireside and waterside from corrosion.

1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.

2. After boiler is filled with water, and left not fired for more than 10 days, protect by wet storage method recommended by boiler manufacturer.

3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions.
3.4 FLUE CONNECTIONS
   A. Connect breeching to full size of boiler outlet. Comply with requirements in Division 23 Section 23 51 00 “Breechings, Chimneys, and Stacks” for venting materials.
   B. Install easily accessible test ports for field testing of flue gas from each boiler.
   C. Install flue-gas economizer with factory-furnished transitions to connect to boiler and to field-installed breeching.

3.5 ELECTRICAL POWER CONNECTIONS
   A. Connect wiring according to Division 26 Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”
   B. Ground equipment according to Division 26 Section 26 05 26 “Grounding and Bonding for Electrical Systems.”

3.6 CONTROLS CONNECTIONS
   A. Install control and electrical power wiring to field-mounted control devices.
   B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.
   C. Connect control wiring between boiler control interface and building control system for remote monitoring and control of boilers. Comply with requirements in Division 23 Section 23 09 00 “Instrumentation and Control for HVAC”.

3.7 NETWORK AND PHONE CONNECTIONS
   A. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.
   B. Connect phone system cable to boiler controls to provide connectivity for remote monitoring and alarm notification through integrated boiler control system.

3.8 FIELD QUALITY CONTROL
   A. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   B. Perform the following tests and inspections.
      1. Perform installation and startup checks according to manufacturer’s written instructions.
      2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
      3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
   b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and steam pressure.
   c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Boiler will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

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

B. Video training sessions and provide electronic copy of video to Owner.

END OF SECTION 23 52 39
SECTION 23 53 13 - BOILER FEEDWATER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes the following:
   1. Feedwater system skid

1.3 DEFINITIONS

A. NPSH: Net-positive suction head.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacity, temperature and NPSH required, pump performance curves with selection points clearly indicated, and furnished specialties and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, method of field assembly, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For feedwater equipment to include in emergency, operation, and maintenance manuals.
1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Fabricate and test unit according to ASME PTC 12.1, "Closed Feedwater Heaters."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: ASME B31.1, "Power Piping," for systems more than 15 psig, ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipping: Clean flanges and exposed-metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

1. The skid system shall be a modular approach with multiple skid base modules to facilitate shipping, handling, and installation.

2. For multiple skid module systems, skid bases shall be match-marked with union connections for piping and junction boxes for electrical wiring conduit at each skid module interface. All interconnecting wiring to be cut-to-length, landed, labeled and coiled at junction boxes at each skid module interface.

B. Store units in dry location.

C. Retain protective flange covers and machined-surface protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with manufacturer’s written rigging instructions.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 FEEDWATER UNITS

A. Manufacturers: Subject to compliance with requirements, provide a complete skid provided by one of the following:

2. Cleaver-Brooks.
3. Hurst Boiler & Welding Company.
B. Description: Factory-assembled and -tested unit consisting of:
   1. Blowdown Separator (or Tank) with Aftercooler
   2. Water softener system
   3. Chemical Feed system
   4. Skid control panel
   5. Accessories

C. Boiler feedwater system
   1. Skids
      a. Skid bases shall consist of 4” x 4” structural steel tube framing with ¼” steel plate
         decking. Fork pockets are provided for rigging and installation
      b. All skid bases, steel piping, and structural supports shall be painted high
         temperature black
   2. Receiver
      a. Vertical 304 Stainless Steel Receiver with inlet, vent, overflow, and drain
      b. Head and shell thickness: 12 gauge
      c. Provided with Lifting eyes and companion flanges.
      d. Capacity: Refer to drawings
      e. Liquid-filled industrial thermometer graduated in both Fahrenheit and Celsius.
      f. Level gage glass with stops at top and bottom.
      g. Feedwater Heater:
         1) Sparger tube
         2) Thermostat
         3) Control valve
      h. Receiver shall have 10 year warranty against corrosion
   3. Pumping system
      a. Triplex arrangement
      b. Construction: Pumps shall be design for low pressure single stage centrifugal type
         constructed of Cast 316 Stainless Steel, with Stainless Steel Impeller
      c. Capacity: Refer to drawings
         1) Each pump shall be sized for a minimum of 2 times the boiler evaporation
            rate.
         2) Each pump shall be close coupled to a 3450 RPM C-Face TEFC motor
         3) Mechanical shaft seal shall be rated for 250 degrees F continuous operation
      d. Provided with suction and discharge isolation valve, inlet strainer, discharge check
         valve, and liquid-filled pressure gage for each pump
      e. Pumps shall have a 5-year warranty against corrosion of the SS components
4. **Makeup Water Assembly:** The water make-up assembly shall consist of a float switch mounted at the water make-up level in the tank. A control system will electronically activate a solenoid valve to add softened make-up water to the tank.
   a. A non-siphon filler well (air gap assembly) shall be provided.

5. **Electrical connections:**
   a. Skid to be provided with single point power connection to skid control panel. Skid Control panel shall be NEMA 1 enclosure and include
      1) Main power fused disconnect
      2) Power transformer for line voltage loads
      3) Disconnects for each component
      4) Fusing for all loads
      5) Hand-Off-Auto switches
      6) indicator lights
      7) starters and overloads
      8) Minimum SCCR rating of 65kA

6. **Control Panel**
   a. The control panel shall include a NEMA 1 Steel Enclosure
   b. Motor Starters
   c. Class 10 Solid State Overloads
   d. Pump Fuse Protection
   e. HOA Selector Switches
   f. Pump Run Indicator Lights
   g. Designed to receive pilot signal from boiler(s)
   h. UL 508 Labeled

D. **Blowdown Separator**
1. **Vessel:** 5/16” Welded Carbon Steel Vessel Designed and stamped to ASME Code for 250 psig at 450 Deg. F.
2. **Connections:** Threaded
3. **Arrangement:** Tangential inlet with stainless steel striking plate at point of impingement, a centrally located steam vent for clean quite release of steam to atmosphere, and bottom drain fitted with a stainless steel spiral baffle
4. **Operation:** Intermittent bottom blowdown valve
5. **Capacity and Characteristics:** See Drawings
6. **Accessories:**
   a. Furnish and install W/3 Angle Legs for Floor Mounting.
   b. Provided with temperature regulator Valve sized for cooling water at 50 psig to 140 degree F., Strainer, and 2” Dial Bimetal Thermometer
E. Water softener system

1. System shall be capable to automatically to remove mineral hardness from the water supply as determined by an accepted ASTM or AWWA test method when the system is operated at 16 gpm at 10 psi drop and in accordance with the operating instructions.

2. Basis of Design
   a. The system will be capable of operating under the following conditions:
      b. Temperature: 35 to 100°F (1.6 to 48.9°C)
      c. Pressure: 25 to 120 psi (1.7 to 8.2 bar)
      d. Electrical requirements: 24V, 60Hz, 1ph (Operating)
      e. 460V, 60Hz, 3ph (Incoming)

3. Softener Tanks
   a. The tanks shall be designed for a working pressure of 150 psi, hydrostatically tested at 50% in excess and rated at burst of four (4) times working pressure. A minimum freeboard volume of 50% shall be provided to assure adequate bed expansion during backwash. Tanks shall be manufactured of durable composite resin and reinforced with high-tensile strength filament windings. Tanks are resistant to corrosion, providing years of reliable service. Thermoplastic liners shall be made of high strength polyethylene. A molded plastic base supports the fiberglass tanks. Tanks shall be tested and certified by NSF. Including the base, each vessel shall have nominal dimensions of 9 inches diameter x 48 inches height.

4. Main Control Valve
   a. The control valve shall have 1 inch NPT inlet and outlet connections. It shall be a low lead brass mechanically actuated, hydraulically balanced, self-cleaning piston six-position type to accomplish the regeneration steps of backwash, brine draw, slow rinse, fast rinse, and refill. Separate rinse and timed refill positions will be provided to reduce regeneration water use. The valve shall contain fixed orifice eductor nozzle and self-adjusting backwash flow control. The bypass body, like the main control valve, shall be actuated by a mechanical drive when used. The valve will be capable of being manually stepped through regeneration without electrical power. The valve body will be constructed of low lead brass meeting the requirements of NSF 61.

5. Distribution System
   a. The soft water collector and backwash water distributor shall be a single point fine-slotted self-cleaning plastic manifolds with slots no larger than 0.010-inch width.

6. Brine System
   a. A combination salt storage tank with cover and brine tank well shall be supplied as part of the system. The tank shall be sufficient size to hold salt for at least 65 regenerations between refills. The tank(s) shall be made of corrosion-free one-piece molded polyethylene or fiberglass reinforced plastic material. The tank(s) shall have a nominal diameter of 18 inches and a height of 40 inches.

7. Ion Exchange Resign and Underbedding
   a. Each softener tank shall be provided with 1.0 cubic feet of high capacity synthetic ion exchange resin having a minimum exchange capacity of 30,000 grains per cubic foot when regenerated with 15 pounds of salt per cubic foot. The resin shall be solid, with uniform particle size, clean and free of dirt and extraneous matter that might...
interfere with flow of water through the resin or that might interfere with the ion exchange process.

b. The resin will rest on a bed of quartz at least two inches in depth above the distributor. The quartz shall be washed and dried to remove the debris and fines, and screened not to exceed 16 mesh size by 3/16-inch particle size.

8. Electronic Demand – Twin Alternating

a. This computer-based demand (meter) initiated controller operates system from 1 to 2 units in single, parallel or alternating operating configurations. The control will utilize alphanumeric, self-prompting programming for simple start up. EEPROM memory shall store program data eliminating need for battery back-up or configuration input after power loss. It is pre-wired and includes twist lock electrical end connectors for installation ease.

b. The controller will constantly monitor current operating condition and be capable of displaying instantaneous flow rate through the system. A resettable totaling flow counter will be included to measure total water processed.

c. The control shall be self-diagnostic and capable of emitting an audible signal and error specific messages if it detects a system problem. Valve and control operation will be 24V, 60Hz, 1ph A suitably sized UL/CSA listed transformer(s) will be provided to convert 120V, 60Hz, 1ph power for system operation. Control printed wiring assemblies will be conformably coated to MIL specifications suitable for use in humid environments. A watertight enclosure will be used to house the control.

d. This duplex meter-initiated system has one unit(s) on line, and a companion in standby, or regeneration. Regeneration is immediate based a batch count. The standby unit moves to line position. Built in interlock does not allow more than one unit to be in regeneration at a time.

9. Flow Sensors

a. A turbo flow sensor which is a solid-state proximity transducer with a self-lubricated riding on a sapphire bearing. The sensor shall be made with no packing glands or rotating shaft seals. The sensor shall be made in such a way that it can be installed and removed with simple hand tools. Pipe size of the sensor(s) shall be 1 inch(es). It shall have a minimum flow of 1 gpm, and a peak flow of 50 gpm.

10. Instructions

a. A complete set of instructions for installation and operation of the softener system will be included.

11. Limited Warranty

a. Components such as resin and brine tanks, control valves, etc., will be warranted for one year against failure caused by faulty material, workmanship, or defective parts. Fiberglass tanks shall have a 5-year guarantee.

F. Chemical treatment system

1. Provide complete packaged chemical treatment system including:

a. Chemical metering pumps

1) Solenoid type pump will offer adjustable, manual control from adjustable stroke length, 0-100% throughout the rated capacity of the pump.

2) Pump shall have circuit protection against voltage and current upsets. Solenoid will be protected against thermal overload with auto-reset.
3) The pump must be Water Resistant, acceptable for outdoor and indoor applications.

4) The pump must have ball guided ball check Valve systems to prevent back flow and enhance outstanding priming characteristics.

5) The liquid end of the pump and the injection quill must be made of PVDF=Polyvinylidene Fluoride.

6) The balls in ball check design must be made of ceramic material.

7) Injection nozzles must be capable of handling temperatures of up to 250°F.

8) Pumps must be equipped with durable leak-free bleed valve assembly to insure safe and easy priming.

9) Standard pump has 24 gallon capacity.

b. Chemical mix/storage tank

1) All tanks meet or exceed secondary containment regulations set under EPA 49CFR.

2) Each tank must be square and natural colored.

3) All tanks must be designed with pump mounting surface, female threaded connections and twist lid inspection port.

4) Tanks must be constructed of Low Density Polyethylene.

5) Tank size is 20 gallons, tank – 18"w x 18"l x 24"t.

G. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 80 with threaded joints and fittings.

H. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

1. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, receiver low-water-level alarm, receiver high-water-level alarm, feedwater temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before feedwater unit installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting feedwater unit performance, maintenance, and operations.

1. Final feedwater unit locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 INSTALLATION

A. Equipment Mounting:
1. Install feedwater units on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 Section 03 30 00 “Cast-in-Place Concrete.”

B. Common headers and interconnecting piping shall be complete and installed. Sub-systems, such as blowdown, feedwater, and chemical treatment piping shall be knocked down as required for shipment and installation. Contractor shall coordinate all components required for a complete and operational system. All items identified in submittal as “by others” are the responsibility of the installing contractor to coordinate, procure, install, and commission.

C. Install unit to permit access for maintenance.

D. Support piping independent of pumps.

E. Install base-mounted pumps on concrete bases with grouted base frames.

F. Install parts and accessories shipped loose.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to skid to allow service and maintenance.

C. Connect makeup water piping and cooling-water piping with reduced-pressure backflow preventers.

D. Install overflow drain piping to nearest floor drain.

E. Install vents and extend to outdoors; terminate with elbow turned down and an insect screen.

F. Route and connect all interconnecting piping and wiring for a complete and operational system.

G. Connect all electrical power. Refer to division 26 for requirements.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with manufacturer's written instructions.
   2. Test and adjust controls and safeguards. Replace damaged and malfunctioning controls and equipment.
   3. Check bearing lubrication.
   4. Verify proper motor rotation.
5. Startup service.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust boiler water-level controls to properly stage unit.
B. Set field-adjustable, makeup water and cooling-water controls.

3.6 CLEANING

A. Clean equipment internally; remove coatings applied for protection during shipping and storage, foreign material, and oily residue according to manufacturer's written instructions.
B. Clean strainers.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain system.
B. Engage water treatment specialist for system Start-up, service, and operation in addition to equipment provider. Refer to 23 25 00 HVAC Water Treatment for additional requirements.

END OF SECTION 23 53 13
SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Packaged energy recovery units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which equipment or suspension systems will be attached.

B. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) of each type of filter specified.
   2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.
   3. Wheel Belts: One set(s) of belts for each heat wheel.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance:

C. ASHRAE Compliance:
   1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:
   1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.8 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than **five** years from date of Substantial Completion.

2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than **10** years from date of Substantial Completion.

3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than **three** years from date of Substantial Completion.

4. Warranty Period for Control Boards: Manufacturer's standard, but not less than **three** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON
2. Daikin Applied
3. Trane.
4. Johnson Controls
5. Addison

B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and caulked weathertight, removable panels with neoprene gaskets for inspection and access to internal parts, minimum 1-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood, with damper for exhaust.
   b. Supply: Gravity backdraft damper

2. Roof Curb: Refer to Section 07 72 00 "Roof Accessories" for roof curbs and equipment supports.

D. Heat Recovery Device: Heat wheel

E. Supply and Exhaust Fans: Forward-curved, centrifugal or SWSI centrifugal flexible duct connections.

1. Motor and Drive: [Direct driven] [Belt driven with adjustable sheaves, motor mounted on adjustable base] [Drive type indicated on Drawings].
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."

3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

4. Spring isolators on each fan having 1-inch static deflection.

F. Cooling Coils: Rated according to ARI 410 and ASHRAE 33
   1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
   2. Casing: Galvanized steel.
   3. Tubes: Copper
   4. Tube Headers: Copper
   5. Fins: Aluminum
   6. Fin and Tube Joint: Mechanical bond.
   7. Leak Test: Coils shall be leak tested with air under water.
   8. Refrigerant Coils:
      a. Suction and Distributor: Seamless copper tube with brazed joints.

G. Cooling-Coil Condensate Drain Pans:
   1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.
   2. Complying with requirements in ASHRAE 62.1.
   3. Drain Connections: At low point of pan with minimum 1 ½”threaded nipple.
   4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

H. Indirect-Fired Gas Furnaces:
      a. AGA Approval: Furnace shall bear label of AGA.
      a. Ignition: Electronically controlled electric spark with flame sensor.
   5. Gas Control Valve: Electronic modulating.
   7. Access: Fabricate section to allow removal and replacement of furnace and to allow in-place access for service.
I. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.
   1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
   2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
   3. Include nonfused disconnect switches.
   4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.

J. Accessories:
   1. Roof Curb: Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches
   2. Louvered intake weather hood with 2-inch-thick filters in V-bank configuration.
   3. Exhaust weather hood with birdscreen.
   4. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single extruded-aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch w.g. and 9 cfm/sq. ft. at 4-inch w.g..

2.2 CONTROLS

A. Time Clock: Solid-state, programmable, microprocessor-based unit for mounting in outdoor NEMA 250, Type 3R enclosure with up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.

B. Refrigerant-Cooling-Coils Controls:
   1. Remote-mounted sensor for field installation in supply-air duct with sensor adjustment located in control panel to control remote condensing unit to maintain temperature.
   2. Wall-mounted, space-temperature sensor with adjustment on remote-control panel controls remote condensing unit to maintain temperature.
   3. Cooling Capacity Control: Multiple steps.

C. Indirect-Fired-Gas-Furnaces Controls:
   1. Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to control gas furnace burner to maintain temperature.
   2. Wall-mounted, space-temperature sensor with adjustment on remote-control panel to control gas furnace burner to maintain temperature.
   3. Burner Controls: Modulating
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section 07 72 00 "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural curbs or pilings. Coordinate wall penetrations and flashing with wall construction. Secure air-to-air energy recovery equipment to structural support with anchor bolts.

D. Install units with clearances for service and maintenance.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Refrigerant Piping: Comply with applicable requirements in Division 23 Section 23 23 00 "Refrigerant Piping."

F. Gas Piping: Comply with requirements in Division 23 Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make connection with AGA-approved flexible connectors.
G. Comply with requirements for ductwork specified in Division 23 Section 23 31 13 "Metal Ducts."

H. Indirect-Fired Furnace Vent Connections: Comply with Division 23 Section 23 51 00 "Breechings, Chimneys, and Stacks."

I. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Adjust seals and purge.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   4. Set initial temperature and humidity set points.
   5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 00
SECTION 23 74 13 – PACKAGED UNITARY ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. This Section includes packaged, outdoor-mounted air conditioning units 20 tons and smaller with the following components and accessories:
   1. Direct-expansion cooling.
   2. Hot-gas reheat.
   4. Economizer outdoor- and return-air damper section.
   5. Integral, space temperature controls.
   6. Roof curbs.

B. Related Sections include the following:
   1. Division 23 Section 23 74 33 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which RTUs will be attached.
   2. Roof openings
   3. Roof curbs and flashing.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set of filters for each unit.

1.8 QUALITY ASSURANCE

A. ARI Compliance:
   1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten years from date of Substantial Completion.
   3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
   4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane.
   2. Carrier Corporation.
   4. Johnson Controls.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   1. Exterior Casing Thickness: 0.0626 inch thick.

C. Inner Casing Fabrication Requirements:
   1. Inside Casing: Galvanized steel, 0.034 inch perforated 40 percent free area.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C 1071, Type I.
   2. Thickness: 1 inch.
   3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
   4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple
   3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, forward curved centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Forward curved shaft mounted on permanently lubricated motor.

E. Fan Motor: Comply with requirements in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:
   1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   3. Coil Split: Row split interlaced.

B. Outdoor-Air Refrigerant Coil:
   1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Hot-Gas Reheat Refrigerant Coil:
   1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: See schedule.

B. Compressor: Hermetic, scroll or inverter scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
C. Refrigeration Specialties:
   1. Refrigerant: R-410A
   2. Expansion valve with replaceable thermostatic element.
   3. Refrigerant filter/dryer.
   5. Automatic-reset low-pressure safety switch.
   8. Brass service valves installed in compressor suction and liquid lines.
   9. Low-ambient kit high-pressure sensor.
   11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
   12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION
   A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      1. Pleated: Minimum 90 percent arrestance, MERV 8 Pre, and MERV 13 Final.

2.7 GAS FURNACE
   A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
      1. CSA Approval: Designed and certified by and bearing label of CSA.
   B. Burners: Stainless steel.
      1. Fuel: Natural gas.
      2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
   C. Heat-Exchanger and Drain Pan: Stainless steel.
   D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical stainless steel extension.
   E. Safety Controls:
      1. Gas Control Valve: Modulating.
2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section 23 09 00 “Instrumentation and Control for HVAC.”

B. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. 
   g. Degree F indication.
   h. Unoccupied-period-override push button.
   i. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.

C. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section 28 31 11 "Digital, Addressable Fire-Alarm System" and Division 28 Section 28 31 12 "Zoned (DC Loop) Fire-Alarm System."

d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than [0 deg F]
e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.

3. Scheduled Operation: Occupied and unoccupied periods on [seven] [365]-day clock with a minimum of [two] [four] programmable periods per day.

4. Unoccupied Period:
   a. Heating Setback: 10 deg F.
   c. Override Operation: Two hours.

5. Supply Fan Operation:
   a. Occupied Periods: Run fan continuously.
   b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain room or discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
   b. Unoccupied Periods: Compressors off.

7. Hot-Gas Reheat-Coil Operation:
   a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
   b. Unoccupied Periods: Reheat not required.

8. Gas Furnace Operation:
   a. Occupied Periods: Modulate burner to maintain room or discharge temperature.
   b. Unoccupied Periods: Cycle burner to maintain setback temperature.

9. Economizer Outdoor-Air Damper Operation:
   a. Occupied Periods: Open to [10] [25] percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
   c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.
10. Carbon Dioxide Sensor Operation:
   a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1,000-ppm concentration.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

11. VVT Relays:
   a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Section 23 36 00 "Air Terminal Units" and Section 23 09 00 "Instrumentation and Control for HVAC."

D. Interface Requirements for HVAC Instrumentation and Control System:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
   3. Provide **BACnet** compatible interface for central HVAC control workstation for the following:
      a. Adjusting set points.
      b. Monitoring supply fan start, stop, and operation.
      c. Inquiring data to include **outdoor-air damper position**, supply- and room-air temperature and humidity.
      d. Monitoring occupied and unoccupied operations.
      e. Monitoring constant and variable motor loads.
      f. Monitoring variable-frequency drive operation.
      g. Monitoring cooling load.
      h. Monitoring economizer cycles.
      i. Monitoring air-distribution static pressure and ventilation air volume.

2.11 ACCESSORIES
   A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. [*Outlet shall be energized even if the unit main disconnect is open.*]
   B. Filter differential pressure gauge with integral switch with sensor tubing on either side of filter. Set for final filter pressure loss.
   C. Coil guards of painted, galvanized-steel wire.
   D. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURBS
   A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
      1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
a. Materials: ASTM C 1071, Type I or II.

b. Thickness: **1 inch**

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   
a. Liner Adhesive: Comply with ASTM C 916, Type I.
   
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
   
d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: **14 inches**

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Equipment Mounting:

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA’s "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section 07 72 00 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural **curbs** or pilings. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, Division 22, and Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

C. Install piping adjacent to RTUs to allow service and maintenance.
   1. Gas Piping: Comply with applicable requirements in Division 23 Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

D. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   1. Install ducts to termination at top of roof curb.
   2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section 23 33 00 "Air Duct Accessories."
   4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
   a. Start refrigeration system.
   b. Do not operate below recommended low-ambient temperature.
   c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
   a. Measure gas pressure on manifold.
   b. Inspect operation of power vents.
   c. Measure combustion-air temperature at inlet to combustion chamber.
   d. Measure flue-gas temperature at furnace discharge.
   e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
   f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outdoor-air, dry-bulb temperature.
   d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Relief-air volume.
   d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   b. Low-temperature safety operation.
   c. Filter high-pressure differential alarm.
   d. Economizer to minimum outdoor-air changeover.
   e. Relief-air fan operation.
   f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.
3.7 DEMONSTRATION

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

END OF SECTION 23 74 13
SECTION 23 74 33 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating with heat recovery.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
B. Shop Drawings:
1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:
   a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set[s] for each belt-driven fan.
   2. Filters: One set[s] for each unit.

B. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than **five** years from date of Substantial Completion.
   2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than **10** years from date of Substantial Completion.
   3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than **three** years from date of Substantial Completion.
   4. Warranty Period for Control Boards: Manufacturer's standard, but not less than **three** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAON.
   2. Trane
2.2 PERFORMANCE REQUIREMENTS

A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

B. Cabinet Thermal Performance:
   1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
   2. Maximum Overall U-Value: 0.10 Btu/h x sq. ft. x deg F.
   3. Include effects of metal-to-metal contact and thermal bridges in the calculations.

C. Cabinet Surface Condensation:
   1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
   2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

E. Cabinet Deflection Performance:
   1. Walls and roof deflection shall be within $1/240$ of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
   2. Floor deflections shall be within $1/240$ of the span considering the worst-case condition caused by the following:
      a. Service personnel.
      b. Internal components.
      c. Design working pressure defined for the walls and roof.

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 CABINET

A. Construction: Double wall.

B. Exterior Casing Material: **Galvanized steel with paint finish.**

C. Interior Casing Material: **Galvanized steel.**

E. Base Rails: **Galvanized** steel rails for mounting on roof curb or pad as indicated.

F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
   1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

G. Roof: Standing seam or membrane; sloped to drain water.

H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

I. Cabinet Insulation:
   1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II
   2. Thickness: **1 inch**
   3. Insulation Adhesive: Comply with ASTM C 916, Type I.
   4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:
   1. Shape: Rectangular, with 2 percent slope in at least two planes to direct water toward drain connection.
   2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
      a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      b. Depth: A minimum of 2 inches deep.
   5. Drain Connection:
      a. Located on [both ends] of pan, at lowest point of pan.
      b. Terminated with threaded nipple.
      c. Minimum Connection Size: **NPS 1**

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter curb of sheet metal, minimum **16 inches** high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
2.4 SUPPLY FAN

A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.
   1. Fan Wheel Material: **Coated** steel, mounted on solid-steel shaft.
   2. Bearings: **Self-aligning, permanently lubricated ball bearings**

B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
   1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
   5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.

C. Service Factor for Belt Drive Applications: **Multiple** V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.

D. Motors:
   1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
   2. Enclosure: **Open dripproof**
   4. Service Factor: 1.15

E. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with **elastomeric** isolators.

2.5 HEAT RECOVERY WHEELS

A. Casing:
   1. Steel with standard factory-painted finish.
   2. Integral purge section limiting carryover of exhaust air to between **0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg** differential pressure.
   3. Casing seals on periphery of rotor and on duct divider and purge section.
   4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or **permanently lubricated bearings**. Support horizontal rotors on tapered roller bearing.

B. Rotor: Aluminum segmented wheel strengthened with radial spokes
   1. Maximum Solid Size for Media to Pass: **800** micrometer.

C. Rotor: **Polymer** segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
   1. Maximum Solid Size for Media to Pass: **800** micrometer.
D. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 “Common Motor Requirements for Mechanical Equipment.”
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

E. Controls:
   1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
   2. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.
   4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

2.6 COOLING COILS

A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410

B. Coil Casing Material: Manufacturer's standard material

C. Tube Material: Copper

D. Tube Header Material: Manufacturer's standard material

E. Fin Material: Aluminum

F. Fin and Tube Joints: Mechanical bond.

G. Leak Test: Coils shall be leak tested with air underwater.

H. Refrigerant Coil Capacity Reduction: Circuit coils for face control.

I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.

2.7 REFRIGERATION SYSTEM


B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

C. Compressors: Reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
D. Refrigerant: **R-410A**.
   1. Classified as Safety Group A1 according to ASHRAE 34.
   2. Provide unit with operating charge of refrigerant.

E. Refrigeration System Specialties:
   1. Expansion valve with replaceable thermostatic element.
   2. Refrigerant dryer.
   3. High-pressure switch.
   4. Low-pressure switch.
   5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   6. Brass service valves installed in discharge and liquid lines.

F. Capacity Control:
   1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.

G. Refrigerant **condenser and reheat condenser** coils:
   1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
   2. Tube Material: Copper.
   3. Fin Material: **Aluminum**
   5. Leak Test: Coils shall be leak tested with air underwater.

H. Condenser Fan Assembly:
   1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
   2. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20.05.13 “Common Motor Requirements for Mechanical Equipment.”
      b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
      c. Enclosure Materials: Manufacturer standard
      d. Motor Bearings: **Permanently lubricated bearings**.
      e. Built-in overcurrent and thermal-overload protection.
      f. Efficiency: Premium efficient.
   3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:
1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

2.8 INDIRECT-FIRED GAS FURNACE HEATING
A. Furnace Assembly:
1. Factory assembled, piped, and wired.
3. AGA Approval: Designed and certified by and bearing label of AGA.
B. Burners:
3. Ignition: Electronically controlled electric spark with flame sensor.
D. Venting: Gravity vented.
E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.
F. Safety Controls:
1. Gas Control Valve: Electronic modulating.

2.9 OUTDOOR-AIR INTAKE HOOD
A. Type: Manufacturer's standard hood or louver.
B. Materials: Match cabinet.
C. Bird Screen: Comply with requirements in ASHRAE 62.1.
D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.10 FILTERS
A. Disposable Panel Filters:
1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Thickness: 2 inches.
4. Minimum Arrestance: 80, according to ASHRAE 52.1.
5. Minimum MERV: 13 according to ASHRAE 52.2.

2.11 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a [single-point] field power connection to unit.

B. Enclosure: NEMA 250, [Type 4], mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Power Interface: Field power interface shall be to [NEMA KS 1, heavy-duty, nonfused disconnect switch].

F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
   1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   2. NEMA KS 1, heavy-duty, nonfusible switch.
   3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

I. Controls: Factory wire unit-mounted controls where indicated.

J. Lights: Factory wire unit-mounted lights.

K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

L. Control Relays: Auxiliary and adjustable time-delay relays.

2.12 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."

B. Control Valves: Comply with requirements in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."

C. Control Wiring: Factory wire connection for controls' power supply.
D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

E. Unit-Mounted Status Panel:
1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:
   a. Filter dirty.
   b. Fan operating.
   c. Cooling operating.
   d. Heating operating.
   e. Smoke alarm.
   f. General alarm.
4. Digital Numeric Display:
   a. Outdoor airflow.
   b. Supply airflow.
   c. Outdoor dry-bulb temperature.
   d. Outdoor dew point temperature.
   e. Space temperature.
   f. Supply temperature.
   g. Space relative humidity.
   h. Space carbon dioxide level.

F. Control Dampers:
1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
4. Damper Label: Bear the AMCA seal for both air leakage and performance.
5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
6. Damper Frame Material: Extruded aluminum
7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.
8. Blade Material: Extruded aluminum
13. Airflow Measurement:
   a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
   b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
   c. Accuracy of flow measurement: Within $\frac{5}{10}$ percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
   d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
   e. Flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

G. Damper Operators:
   1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
   2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
   3. Maximum Operating Time: Open or close damper 90 degrees in 60 seconds.
   4. Adjustable Stops: For both maximum and minimum positions.
   5. Position Indicator and Graduated Scale: Factory installed on each actuator with words “OPEN” and “CLOSED,” or similar identification, at travel limits.
   6. Spring-return operator to fail-safe; either closed or open as required by application.
   7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.

H. Refrigeration System Controls:
   1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb. of dry air or outdoor-air temperature is less than 60 deg F.
   2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 55% percent.

I. Furnace Controls:
   1. Remote sensor for field installation in supply-air duct with sensor adjustment located in control panel to modulate gas furnace burner to maintain space temperature.
   2. Staged Burner Control: Modulating control.
   3. Electromechanical or Electronic Burner Control: 10 to 100 percent modulation of the firing rate.

J. Damper Controls: Space pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space at a minimum of 0.05 inch w.g. with respect to outdoor reference.

K. Integral Smoke Alarm: Smoke detector installed in supply and return air.

L. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 23 09 00 "Instrumentation and Control for HVAC." Links shall include the following:
   1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
   2. Hardware interface or additional sensors for the following:
      a. Room temperature.
      b. Discharge-air temperature.
      c. Refrigeration system operating.
      d. Furnace operating.
      e. Constant and variable motor loads.
      f. Variable-frequency-controller operation.
      g. Cooling load.
      h. Economizer cycles.
      i. Air-distribution static pressure and ventilation-air volumes.

M. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
   1. Hardwired Points:
      b. Control: On-off operation, [supply temperature set-point adjustment and space humidity set-point adjustment].
   2. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.
2.13 ACCESSORIES

A. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.

B. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

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

3.2 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
   1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
   2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."
   3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.


D. Install separate devices furnished by manufacturer and not factory installed.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Install drain pipes from unit drain pans to roof drain.
   1. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
      a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Gas Piping Connections:
   1. Comply with requirements in Division 23 Section 23 11 23 "Facility Natural-Gas Piping."
   2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
   3. Install AGA-approved flexible connectors.

C. Duct Connections:
   1. Comply with requirements in Division 23 Section 23 31 13 "Metal Ducts."
   2. Drawings indicate the general arrangement of ducts.
   3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Division 23 Section 23 33 00 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
   1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Inspect units for visible damage to furnace combustion chamber.
   3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
      a. Measure gas pressure at manifold.
      b. Measure combustion-air temperature at inlet to combustion chamber.
      c. Measure flue-gas temperature at furnace discharge.
      e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   a. High-limit heat exchanger.
   b. Alarms.
5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.
7. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
25. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.
a. Supply-air volume.
b. Return-air flow.
c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

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

END OF SECTION 23 74 33
SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. LEED Submittals:
   1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.
1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Filters: One set(s) for each air-handling unit.
      2. Gaskets: One set(s) for each access door.
      3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. ASHRAE Compliance:
      2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - “Outdoor Air Quality,” Section 5 - “Systems and Equipment,” Section 6 - “Procedures,” and Section 7 - “Construction and System Start-up.”
   C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION
   A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
      1. Warranty Period:
         a. For Compressor: Five year(s) from date of Substantial Completion.
         b. For Parts: Two year(s) from date of Substantial Completion.
         c. For Labor: Two year(s) from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. LG.
   2. Mitsubishi.
   4. Panasonic.
   5. Modine

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
   5. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 20 "Common Motor Requirements for Mechanical Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
   6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   7. Filters: Permanent, cleanable.
   8. Condensate Drain Pans:
      a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
         1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
         2) Depth: A minimum of 2 inches deep.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   1) Minimum Connection Size: NPS 1

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enamelled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

3. Fan: Direct drive, centrifugal.

4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 20 "Common Motor Requirements for Mechanical Equipment."
   b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure Type: Totally enclosed, fan cooled.
   d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   f. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Condensate Drain Pans:
   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 1 inch deep.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      1) Minimum Connection Size: NPS 1
   d. Pan-Top Surface Coating: Asphalitic waterproofing compound.

7. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:
1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 1 inch
3) Arrestance according to ASHRAE 52.1: 80.
4) Merv according to ASHRAE 52.2: 5

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant Charge: R-410A
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Section 23 09 00 “Instrumentation and Control for HVAC.”

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements specified in Division 23 Section "Hydronic Piping" and Division 23 Section "Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Division 23 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION 23 81 26
SECTION 23 81 29 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:

1. Outdoor Air Cooled Units
2. Indoor Concealed Ducted Units
4. System refrigerant and oil.
5. System condensate drain piping.
7. Metal hangers and supports.
8. Metal framing systems.
9. Fastener systems.
10. Pipe stands.
11. Equipment stands.
12. Miscellaneous support materials.
13. Piping and tubing insulation.

B. Refer to Division 26 sections for the following work; not work of this section.

1. Power supply wiring from power source to power connection on Air Conditioning units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
C. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:

1. Interlock and Control wiring between field-installed controls, indicating devices, and unit control panels.

D. Related Sections:

1. Section 23 09 00 – Instrumentation and Control for HVAC
2. Section 23 23 00 – Refrigerant Piping

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

G. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

H. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

I. VRF: Variable refrigerant flow.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
   4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
   5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
   6. Include description of control software features.
   7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
   8. Include refrigerant type and data sheets showing compliance with requirements indicated.
   9. For system design software.
   10. Indicate location and type of service access.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include rated capacities, size, type, accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Prepare the following by or under the supervision of a qualified professional engineer:
      a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

C. Startup service reports.

D. Coordination Drawings: Plans and details, drawn to scale, on which all units, piping, and associated equipment is drawn indicating arrangement and layout and is coordinated with other building trades and systems. Indicate pipe size, routing, and clearances required.

E. Operation and Maintenance Data: For units to include emergency, operation, and maintenance manuals.

F. Shop Drawings: For VRF HVAC systems.
   1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

4. Include diagrams for power, signal, and control wiring.

G. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.
   1. Include a Sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
   2. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

B. Qualification Data:
   1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
      a. Retain copies of Installer certificates on-site and make available on request.

C. Product Certificates: For each type of product.

D. Product Test Reports: Where tests are required, for each product, for tests performed by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's warranties.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.
1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters:
      a. One set(s) for each unit with replaceable filters.
   2. Indoor Units: One for each unique size and type installed.
   3. Controllers for Indoor Units: One for each unique controller type installed.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
   1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
   2. Installer certification shall be valid and current for duration of Project.
   3. Retain copies of Installer certificates on-site and make available on request.
   4. Each person assigned to Project shall have demonstrated past experience.
      a. Demonstrated past experience with products being installed for period within [three] five consecutive years before time of bid.
      b. Demonstrated past experience on five projects of similar complexity, scope, and value.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
   1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
   2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.
F. The units shall be stored and handled according to the manufacturer’s recommendations and requirements.

1.12 INSTALLATION REQUIREMENTS

A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor’s installation price shall be based on the systems installation requirements. Contractors shall provide 2 references (include project name and contact information) of proof of prior successful installation experience with these systems.

1.13 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:
   a. For Compressors: Five year(s) from date of Substantial Completion.
   b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.
   c. For Labor: Two year(s) from date of Substantial Completion.

1.14 EXTRA MATERIALS

A. General: Furnish to Owner, with receipt, the following extra materials for each indoor unit:

1. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation.
2. Daikin AC.
3. Johnson Controls.
5. Panasonic Corporation.
6. Trane.

B. Basis of design manufacturer noted above shall include components for a complete working system, including electrical and control work. If basis of design manufacturer is not selected, contractor is responsible for any additional electrical connections, panels, controls, and equipment as part of alternate acceptable manufacturer's requirements. Mechanical Contractor is responsible for coordination of electrical requirements with Electrical Contractor for manufacturer selected during bidding process to ensure a complete working system.

C. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
   1. Indoor and outdoor units, including accessories.
   2. Controls and software.
   3. HRCUs.
   4. Refrigerant isolation valves.
   5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
   1. **Two-pipe or three-pipe** system design.
   2. System(s) operation, as indicated on Drawings.
   3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:
   1. ASHRAE 15: For safety code for mechanical refrigeration.
   2. ASHRAE 62.1: For indoor air quality.
   3. ASHRAE 135: For control network protocol with remote communication.
   4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

1. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
2. System Refrigerant Piping and Tubing:
   a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor units in compliance with manufacturer requirements and requirements indicated.
   b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
   c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

3. System Controls:
   a. Network arrangement.
   b. Network interface with other building systems.
   c. Product selection.
   d. Sizing.

B. Service Access:
   1. Provide and document service access requirements.
   2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
   3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
   4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
   5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
   6. Comply with OSHA regulations.

C. System Design and Installation Requirements:
   1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
   2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
   1. Not less than 60 percent.
   2. Not more than 130 percent.
   3. Range acceptable to manufacturer.
F. System Turndown: Stable operation down to 40 percent of outdoor-unit capacity.

G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

H. Outdoor Conditions:
   1. Suitable for outdoor ambient conditions encountered.
      a. Design equipment and supports to withstand wind loads of governing code

I. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
   1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
   2. Outdoor: Within ordinance of governing authorities.

J. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

K. Capacities and Characteristics: As indicated on Drawings.

2.4 OUTDOOR AIR COOLED CONDENSING UNITS

A. General Requirements
   1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
   2. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%. Connection ratios higher than 130% shall not be acceptable.
   3. The unit shall incorporate an auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge as additional refrigerant is added to the system and will calculate how much additional refrigerant is added to the system.
   4. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
   5. The outdoor unit shall be capable of 100% heating capacity operation at -10°F dry bulb ambient temperature without additional low ambient controls. Manufacturers that cannot provide heating operation at -10°F shall provide supplemental electric heat or additional low ambient heating components in the condensing unit to allow for operation down to -10°F. All additional engineering, electrical, and installation costs shall be by the unit manufacturer.
   6. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode. Reverse cycle (cooling mode) defrost during heating operation shall not be permitted due to the potential reduction in space temperature. Manufacturers that cannot provide heat while in defrost mode shall provide supplemental electric heat equal to the unit full load heating output. All additional engineering, electrical, and installation costs shall be by the unit manufacturer.

B. Unit Cabinet
   1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
   2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
   3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
C. Fans
1. Outdoor fans shall be direct-drive, propeller type, and shall discharge air vertically. Fans shall below air through the outdoor coil.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

<table>
<thead>
<tr>
<th>Operation Sound (dB)</th>
<th>Night Mode Sound Pressure Level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 max.</td>
<td>55</td>
</tr>
<tr>
<td>Step 2 max.</td>
<td>50</td>
</tr>
<tr>
<td>Step 3 max.</td>
<td>45</td>
</tr>
</tbody>
</table>

D. Compressor
1. Units shall be equipped with inverter driven vapor injection scroll compressors.

E. Outdoor Coil
1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil shall be protected with an integral metal guard.

F. Refrigeration Safeties
1. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

G. Electrical Requirements
1. Unit electrical power shall be a single point connection.
2. The control circuit between indoor units, heat recovery terminal box (MCU/BC/etc.), and the outdoor unit shall be 12VDC, completed using stranded, annealed copper conductor, two-core cable to provide total integration of the system. Twisted pair shielded cable is recommended.
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.
5. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor

2.5 UNIT WITH ONE 2-CABLE WIRE HEAT RECOVERY TERMINAL BOXES (HEAT RECOVERY SYSTEMS ONLY)

A. General
1. The heat recovery terminal boxes are designed specifically for use with variable refrigerant volume heat recovery system components. ‘Heat recovery terminal box’ is a generic term used to describe the various manufacturer terminology for the function of this piece of equipment, including MCU, BC box, etc.
2. Selector boxes shall be factory assembled, wired, and piped. Heat recovery terminal boxes must be run tested at the factory. Selector boxes must be mounted indoors.
3. Heat recovery terminal boxes must be equipped with a circuit board that interfaces to the VRF control network.
B. Unit Cabinet
   1. Units shall have a galvanized steel plate casing. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator. The cabinet shall contain a heat exchanger shall be tube in tube type constructed from ACR copper. Cabinet insulation shall be sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene. **Nominal sound pressure levels shall be 44 dBA or lower as measured at 5 ft.** If a manufacturer’s heat recovery box cannot meet this sound level, the manufacturer shall provide a removable acoustical attenuation package consisting of high density fiberglass mat with a mass-loaded vinyl sandwiched inside a weather-proof jacketing.

C. Refrigerant Valves
   1. The unit shall be furnished with electronic expansion valves to control the direction of refrigerant flow. Solenoid valves shall not be acceptable. Refrigerant connections must be of the braze type.
   2. The heat recovery terminal boxes can have up to six ports of independent heating/cooling operation. All ports shall be isolated with full port isolation valves. Manufacturers who utilize a multi-port heat recovery box with a “master” or single set of solenoid valves at the inlet or outlet of the heat recovery box that can fail and shutdown the entire box shall only use a single port heat recovery box. Heat recovery boxes shall not be piped in series with one another or shall not have the piping trunk main pass through the box. The heat recovery boxes shall be located as shown on the drawings for serviceability.

D. Drain Pan: An integral condensate drain pan and drain shall be provided.

E. Electrical
   1. Refer to schedule on drawings for heat recovery terminal box electrical requirements. The control voltage between the indoor and outdoor unit shall be low voltage DC.

2.6 INDOOR FAN COIL UNITS

A. Concealed Ducted Units
   1. General
      a. Indoor unit shall be a concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation within a conditioned space. It shall have a front discharge air duct collar and filtered back or bottom return air. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. Included as standard equipment, a long-life filter that is mold resistant and a condensate drain pan. Units 4-tons or less shall be equipped with a condensate pump that pumps to 18” from the drain pipe opening. The indoor units sound pressure shall range from 29 dBA to 48 dBA at low speed 5 feet below the suction grille.
   2. Unit Cabinet
      a. The cabinet shall be located into the ceiling and ducted to the supply and return openings. The exterior of the unit shall be 18 gauge galvanized steel. The interior of the cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
   3. Filter
      a. Provide a 1” MERV 13 high efficiency air filter and filter rack for each unit.
   4. Fan
      a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected.
   5. Coil
      a. Coil shall be a 3-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 14 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. A condensate pump with a 9-13/16” lift shall be located below the coil in the condensate pan with a built in safety alarm.
   6. Mixing Box
a. Provide mixing boxes of physical size to match basic unit, and include equal-sized flanged openings capable of handling full air flow. Arrange openings as indicated on drawing sheets. Provide dual action parallel dampers for return air with sealing edges, arranged to operate automatically with one set of linkage. Provide parallel blade damper for outside air directed towards the return air stream for reduced stratification. Provide dampers of balanced construction, rotating in sintered bronze or nylon bearings.

7. Motors
   a. Motor shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.

8. Controls
   a. Refer to section 2.5 and associated M700 series drawings.

9. Operating Characteristics
   a. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled.

10. Electrical
    a. Refer to schedule on drawings for electrical requirements.

11. High Water Alarm
    a. Provide sensor in cooling drain pan that will alarm and shut down unit on high condensate levels for ceiling mounted unit. The sensor will be provide and installed by the temperature controls contractor. The sensor will be wired back the BMS for unit shutdown.

12. Condensate Pump:
    a. Unit shall have a built in condensate pump that can lift the condensate a minimum of 36” above the drain pan and is powered from the unit.

2.7 CONTROLS

A. Overview
   1. Packaged controls shall provide all functionality and integration described on associated M700 series control drawings in addition to any other requirements within this section. Provide all controllers, interface modules, BACnet gateways and user interfaces, zone controllers and expansion cards necessary, along with factory-altered control sequences (if necessary) to achieve sequences of operations described. Provide factory start-up and owner training on packaged controls and participate in third party commissioning of the control system.

B. Electrical Characteristics
   1. General: From each circuit board to the controls, the electrical voltage shall be 16 or 12 volts DC.
   2. Wiring:

C. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the heat recovery terminal box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit.
   a. The wire shall be as recommended by equipment manufacturer.

D. Controller Characteristics
   1. Local Wired Remote Controller (Room Thermostat) -
      a. The Local Remote Controller shall be mounted into a standard junction box.
      b. Unit Display
         1) The Local Remote Controller shall have a backlit LCD display. Display information shall be selectable from English, French, or Spanish.
         2) Provide a backlit LCD display with contrast adjustment and auto off after 30 seconds.
         3) The controller shall display Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F (0-32°C). Detailed display will reflect room temperature (0-176°F/-17-80°C range in one degree increments). Display of temperature information shall be configurable for Fahrenheit or Celsius.
         4) On/Off status shall be displayed with an LED.
         5) Error codes will be displayed in the event of system abnormality/error with a two digit code.
6) The following system temperatures can be displayed to assist service personnel in troubleshooting:
   a) Return air temperature
   b) Liquid line temperature
   c) Gas line temperature
   d) Discharge air temperature (if available on the unit)
   e) Remote temperature sensor temperature
   f) Indoor temperature setpoint

c. Operation
   1) The unit shall be capable of controlling a group of up to 16 indoor units. The following operation groups shall be controlled:
      a) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
      b) Independent cooling and heating setpoints in the occupied mode
      c) Independent cooling setup and heating setback
      d) Fan speed
      e) Airflow direction
      f) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
      g) Lock out key settings
      h) Indoor unit group assignment

d. Program Functions
   1) Controller shall support schedule settings with selectable weekly pattern options.
      a) Seven day week
      b) Weeday + weekend
      c) Weekday + Saturday + Sunday
      d) Independently settable Cooling and/or Heating setpoints when unit is on (occupied).
      e) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
      f) A maximum of 5 operations can be schedulable per day
      g) Time setting in 1-minute increments
   2) The Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat according to the room temperature and temperature setpoint.
      a) Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C).
      b) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C).
   3) The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
      a) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
      b) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.
   4) The space temperature shall be capable of being sensed at either the local controller, the return air temperature sensor mounted in the unit, or a remote temperature sensor.

2. Multi-Zone - Centralized Remote Controller (Front End Controller) -

   a. General
      1) The centralized remote controller shall provide control for all indoor units. It shall be capable of controlling indoor fan coil units and indoor unit groups connected to outdoor units. The centralized remote controller shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. If the number of indoor units or condensing units dictates, multiple controllers shall be provided.
      2) The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals of the condensing unit. The centralized remote controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor (s).
      3) The centralized remote controller can be used in conjunction with BACnet, and Lonworks interfaces to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy
chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each indoor unit group associated with the centralized remote controller.

4) The centralized remote controller shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via the internet or Local Area Network (LAN), or connection with a non-networked PC after completed installation.

5) Optional software functions shall be available so that facility staff can securely log into each centralized remote controller via the PC’s web browser to support monitoring, scheduling, error email, and general user functions. Additional optional software functions of individual unit power usage and distribution, Tenant Billing, energy optimization services, and HTTP Interface shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license key from manufacturer.

b. Mounting
1) The centralized remote controller shall be mounted on the wall or into a recessed fixing box.

c. Display Features
1) The centralized remote controller shall be approximately a 10" LCD display. Display information shall be selectable from English, French, Italian, German, or Spanish.
2) Featured backlit LCD with contrast adjustment and auto off after 30 minutes (default) is adjustable between 1 to 60 minutes.
3) Area and Group configuration
   a) Area contains one (1) or more Area(s) or Group(s)
   b) A Group may be an indoor unit, Di, Do point that has a network address.
4) An Area is a tiered group where management points (indoor unit, digital input/output, and analog input groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels. Area configuration shall classify levels of monitoring and control for each management point.

5) The Controller shall display Date (mm/dd/yyyy or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).
6) The Controller shall adjust for daylight savings time (DST) automatically.
7) Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.
8) System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Set Schedule/Setback/Auto-changeover, Filter, and Screen Lock.
9) The controller shall display the temperature setpoint in one degree increments with a range of 60°F - 90°F (16°C - 32°C). Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
10) Display shall reflect room temperature 0°F - 176°F (-18°C - 80°C) range in one degree increment.
    a) Display of room temperature information shall be configurable for Fahrenheit or Celsius.
11) The system setting mode shall be used to configure options and display information for each Zone or Group.
12) Zone configuration shall display Setpoint Range Limitation, Setback Temperature setting, and Auto-changeover for each Zone.
13) Floor plan layout: Capable of displaying site floor plan as the background for visual navigation. Indoor unit, DIII-NET Di and Dio, and External Di, DO, and Ai icons with operational status can be placed on the floor layout. Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode). Digital input and output icons will display On/Off status. Analog input icons will display analog value. The system shall have the ability to create up to 60 floor layout sections.
14) Indoor units shall be capable of being displayed by Zone or Group.
    a) Zones configuration via the centralized remote controller shall consist of a single indoor unit group or a collection of indoor unit groups blocked together for control and monitoring purposes.
    b) Groups shall consist of 1 to 16 indoor units daisy chained together via the remote control wiring to the indoor unit terminal block for control and monitoring purposes.
c) Groups and Zones may be assigned names (ex. Office 101, Lobby, North Hallway, etc…)

15) Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon.
   a) System errors are generated when the centralized remote control system with other VRV controls systems combined or power proportional distribution calculation errors occur. The centralized remote control system shall display the error with a red triangle placed on the lower task bar. Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon. Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon. Communication errors between the centralized remote control system and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon. Error history shall be available for viewing for up to 500,000 errors/abnormality event.

d. Basic Operation:
   1) Capable of controlling Zone(s) or Group(s) of up to 64 indoor unit groups (128 indoor units).
   2) Controller shall control the following group operations.
      a) On/Off
      b) Operation Mode (Cool, Heat, Fan, Dry, and Auto)
      c) Independent Cooling and Heating setpoints in the occupied mode
         - Cooling setpoint shall be maintained higher than or equal to the heating setpoint
         - Adjustable minimum setpoint differential 0 - 70F (0 - 40C) between cooling and heating setpoint
         - Selectable single setpoint mode
      d) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 40 - 95F (5 - 35C).
         - Setup and Setback setpoints shall be set outside of the occupied setpoint range.
         - The recovery differential shall be 40F (default) and adjustable between 2 – 100F.
         - Settings shall be applied based upon the Zone configurations.
      e) Fan Speed
         - Up to 3 speeds (dependent upon indoor unit type).
      f) Airflow direction
         - 5 fixed positions or swing position.
      g) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Zone configurations.
      h) Remote controller permit/prohibit of On/Off, Mode, and Setpoint.

3) Capable of providing battery backup power for up to 1 years in total time for the clock. All settings shall be stored in non-volatile memory.

e. Programmability
   1) Controller shall support weekly schedule settings.
      a) Selectable weekly patterns
         - 7-day
         - Weekday + Weekend
         - Weekday + Saturday + Sunday
      b) The schedule shall support unit On/Off.
      c) 100 independent schedules configurable with up to 20 events settable for each schedule.
         - Each scheduled event shall specify time and target Zone or Group
         - Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) Setpoint, Setback (Heating) Setpoint, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, and Timed Override Enable.
• Independently settable Cooling and Heating setpoints when unit is On (occupied).
• Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied) by Zone.
• Time setting in 1-minute increments.
• A 2 hour override shall be provided for use enabling indoor unit operation during the unoccupied period.

d) A maximum of 40 exception days can be schedule on the yearly schedule.
• Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions.
• Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September).

2) Auto-changeover
   a) Auto-change shall provide Individual, Fixed, and Averaging changeover methods for both Heat Pump and Heat Recovery systems based upon the Zone configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
   b) Individual method (recommended for Heat Recovery Systems)
      • Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the Zone.
      • Changeover affects individual indoor unit group in the Zone.
   c) Fixed method
      • Changeover evaluated by room temperature and setpoints of the representative unit (first registered unit) in the Zone.
      • Changeover affects all indoor unit groups in the Zone.
   d) Average method
      • Changeover evaluated by the average of all indoor unit group’s room temperatures and setpoints in the Zone.
      • Changeover affects all indoor unit groups in the Zone.
   e) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same condensing unit in the Heat Pump system or branch selector box in the Heat Recovery system.
   f) Changeover to cooling mode shall occur when the room temperature is greater than or equal to the cooling setpoint, and the room temperature is greater than or equal to the average of the cooling and heating setpoints + 2.7°F.
   g) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint, and the room temperature is less than or equal to the average of the cooling and heating setpoints - 2.7°F.
   h) One hour guard timer
      • Upon changeover, guard timer will prevent another changeover during this period.
      • Guard timer is ignored by a change of setpoint manually from either centralized remote controller, local remote controller or by schedule.
      • 60 minutes as default, configurable to 15, 30, or 90 minutes.
   i) Third party devices
      • Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control groups or zones corresponding to the change of the operation states or the On/Off states of any group.
      • Requires digital input/output unit.
      • On/Off based monitoring and control of equipment.
      • Manual or scheduled operation of equipment.
      • Operation based upon interlock with VRV indoor unit group(s).
      • Monitor equipment error/alarm status.
   j) Controller shall support force shutdown of associated indoor unit groups.
   k) Interlock with other equipment
Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control groups or zones corresponding to the change of the operation states or the On/Off states of any group.

Requires digital input/output unit.

Software

1) Licensed per option, per centralized remote controller shall be required. All PCs shall be field supplied.
   a) Web/Email software
      - Each centralized remote controller shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (128 indoor unit groups with the addition of an expansion module) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 3 email addresses).

b) Power Proportional Distribution (PPD)
   - The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the condensing unit(s) divided among the associated indoor units. This software is used in conjunction with the centralized remote controller and a Watt Hour Meter (WHM). A maximum of 3 Watt Hour Meters can be connected to the centralized remote controller.
   - The Power Proportional Distribution results data can be saved to a PCMCIA card, or on a PC with the use of the web option software. Data is saved in the CSV format. Results can be stored up to 12 months.

c) HTTP Interface
   - This option shall be capable of creating a software interface between the VRV Controls Network and Home Automation control systems.

3. BAS Gateway- BACnet or LonTalk
   a. General
      1) The Interface for use in BACnet or LonTalk shall provide the gateway for a Building Management System (BMS) to perform all controlling functions related to the spaces served by all indoor and condensing units. It shall be capable of controlling the complete system. Each system is independent of each other and each system will terminate on its own ports.

      2) The Interface shall allow the BMS to supersede all of the controlling functions of the local centralized controller, local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. All controlling parameters and logic shall reside in the BMS and shall be accomplished through programming at the BMS front end controllers.

      3) The Interface for use in BACnet uses a standard open protocol based on ANSI/ASHRAE Standard 135. The BACnet Interface has been certified by the BACnet Testing Laboratories (BTL). The BACnet Interface is compatible with BACnet IP (ISO16484-5). Interfaces that have not been certified by the BACnet Testing Laboratories shall not be acceptable.

      4) The interface wiring shall consist of a non-polar two-wire connection to the terminals of the condensing unit. The Interface shall be wall mounted and is used as a translator between the Building Management System (BMS) and the VRV communication bus to maintain and control the operation of the connected indoor unit(s).

      5) The Interface shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the Internet or Local Area Network (LAN). The Ethernet connection shall be capable of transmission on 10Base-T and/or 100Base-TX connection at 100 Mbps.

      6) The Interface shall be capable of being configured as a foreign device. It shall be capable of communicating across LonMark certified or BACnet Broadcast Management Devices (BBMD) in different subnet networks.
7) The Interface shall be capable of supporting Change of Value (COV) notification for all available objects.

8) A setup tool shall be available so that certified commissioning personnel/facility staff can securely log into each Interface via a PC to support the configuration and testing of the Interface.

b. Mounting
1) The Interface shall be mounted on the wall or in an enclosure.

c. Display Features
1) The Interface shall be approximately 10.5” x 10.5” x 4.0” in size.
2) LED display provides the interface’s operational status and alarm.
3) The Interface shall be capable of displaying indoor unit objects on the BACnet building management system. It shall provide the building management system the capability to command the setpoint temperature in 1°F (0.1°C) increments with a range of 60°F - 90°F (16°C - 32°C). Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
4) The Interface shall provide the BACnet building management system the capability to display the room temperature in 0.1°F (0.1°C) increments with a range of -120°F -180°F (-84°C - 82°C). Display of room temperature information shall be configurable for Fahrenheit or Celsius.
5) Error codes generated by the indoor units, condensing units, heat recovery boxes, and remote controllers shall be displayed on the building management system in the event of system abnormality/error. Communication errors between the Interface and the building management system shall be displayed.

d. Basic Operation
1) The Interface will provide up to 28 objects that can be monitored/controlled via the building management system. It shall be capable of controlling up to 64 indoor unit groups (128 indoor units) per port. Expansion modules can be added to increase the number of ports to a total of 4 ports.
2) The Building Management System shall directly control the following group operations:
   a) On/Off
   b) Operation Mode (Cool, Heat, Fan, Auto, and Dry)
   c) Single setpoint setting for Cooling and Heating in the occupied mode
   d) Fan status
   e) Fan Speed
   f) Up to 3 speeds (dependent upon indoor unit type)
   g) Vane directions
   h) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
   i) Filter sign reset for indoor units
   j) Disable the central controller
   k) Forced off of indoor units
   l) Energy saving offset of indoor unit setpoint
   m) Compressor status
   n) Heater status
3) The interface shall be capable of providing battery backup power for up to 3 years in total time for the clock. Settings shall be stored in non-volatile memory.

e. Programmability
1) The building management system is responsible for all weekly schedule settings through its programming and code.
   a) The schedule shall fully control all functions of the indoor unit as listed in the following:
      • On/Off
      • Each scheduled event shall specify time and target group.
      • Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) setback setpoint, Setup (Heating) setback setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable.
      • Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied) by Group.
• An override shall be provided for use enabling indoor unit operation during the unoccupied period by the building management system programming.

b) The building management system shall perform the auto-changeover through its programming.

• Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow for the optimal room temperature to be maintained by BMS for automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.

• Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same communication bus to the same condensing unit in the Heat Pump system or the same heat recovery box in the Heat Recovery system.

• Changeover to cooling mode shall occur when the room temperature is greater than or equal to the cooling setpoint.

• Differential is determined and set by the building management system programming.

• Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint. Differential shall be controlled by the building management system programming.

c) The Guard Timer- Upon changeover, the guard timer will prevent another changeover during this period. The Guard timer should be ignored by a change of setpoint manually from the BMS, centralized controller, local remote controller, or by schedule. The guard timer shall be controlled and configured by building management system programming (30 minute minimum recommended).

d) The Interface shall allow the BMS to force a shutdown of associated indoor unit groups.

2.8 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

2. ASHRAE 34, Class A1 refrigerant classification.


B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.9 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L or Type DWV according to ASTM B306.

2.10 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Division 23 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Tubing Kits:
1. Furnished by VRF HVAC system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
5. Factory Charge: Dehydrated air or nitrogen.

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves:
1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.11 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel or stainless steel.

B. Plastic Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel or stainless steel.
2.12 MISCELLANEOUS SUPPORT MATERIALS

A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.13 PIPING AND TUBING INSULATION

A. Comply with requirements in Division 20 "Mechanical Insulation" for system piping insulation requirements.

2.14 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.
   1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
      a. Flame Travel Distance: 60 inches or less.
      b. Peak Optical Smoke Density: 0.5 or less.
      c. Average Optical Smoke Density: 0.15 or less.
   2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
   3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:
   1. Paired Cable: NFPA 70, Type CMG.
      a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
      b. PVC insulation.
      c. Braided or foil shielded.
      d. PVC jacket.
      e. Flame Resistance: Comply with UL 1685.
   2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
b. PVC insulation.
c. Braided or foil shielded.
d. PVC jacket.
e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

C. TIA-485A Network Cabling:
1. Standard Cable: NFPA 70, Type CMG.
   a. Paired, [one pair] [two pairs], twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1685.
2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, [one pair] [two pairs], No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with connectors.
1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
4. Cable Rating: By application.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.15 MATERIALS
A. Steel:
1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:
1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.


E. Comply with Division 23 "Coatings for HVAC" for corrosion-resistant coating.

2.16 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

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 products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:
   1. Maintain manufacturer's recommended clearances for service and maintenance.
   2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
   1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

F. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

G. Attachment: Install hardware for proper attachment to supported equipment.

H. Grouting: Place grout under equipment supports and make bearing surface smooth.

I. Owner shall witness all testing of the system. Provide 7 days notice to owner prior to start of testing.

J. Provide isolation valves on all piping at connection to equipment so each piece of equipment may be isolated from the rest of the circuit.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Division 07 "Roof Accessories." Anchor units to supports with removable, stainless-steel fasteners.

D. Owner shall witness all testing of the system. Provide 7 days notice to owner prior to start of testing.
E. Provide isolation valves on all piping at connection to equipment so each piece of equipment may be isolated from the rest of the circuit.

### 3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.

2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.

3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

   a. Details indicated on Drawings.

   b. Manufacturer's requirements.
c. Governing codes.
   d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.

5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:
   1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent or as required by code.

C. Pumped Drains:
   1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:
   1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
   2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, 1/4 inch.
   3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:
   1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:
   1. Ream ends of tubes and remove burrs.
   2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
      a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
      b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

C. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

D. Fastener System Installation:
   1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
   3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

E. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 "Roof Accessories" for curbs.
F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel.
   1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Piping and Tubing Insulation:
   1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   2. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

M. Horizontal-Piping Hangers and Supports: Install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu if individual clevis hangers.
   5. Pipe stands for horizontal pipes located outdoors.
   6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

N. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:
   1. Sizes through NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

O. Plastic Pipe Hanger and Support Spacing:
1. Space hangers and supports according to pipe manufacturer's written instructions for service conditions.
2. Maximum spacing, 5 feet; minimum rod size, 1/4 inch.

P. Vertical-Piping Clamps: Install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

Q. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet.

R. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

S. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

T. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

U. Trim excess length of continuous-thread hanger and support rods to 1 inch.

V. Hanger-Rod Attachments: Install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

W. Building Attachments: Install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for metal ducts specified in Division 23 "Metal Ducts."

C. Comply with requirements for nonmetal ducts specified in Division 23 "Nonmetal Ducts."

D. Comply with requirements for air duct accessories specified in Division 23 "Air Duct Accessories."

E. Comply with requirements for flexible ducts specified in Division 23 "Air Duct Accessories."

F. Comply with requirements for grilles, registers and diffusers specified in Division 23 "Grilles, Registers and Diffusers."

3.11 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
   1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Division 26 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Division 26 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.
   2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

A. Cybersecurity:
   1. Software:
      a. Coordinate security requirements with [IT department] [CIO] <Insert entity responsible for IT security>.
      b. Ensure that latest stable software release is installed and properly operating.
      c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:
   a. Coordinate location and access requirements with IT department
   b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
   c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:
   1. Install cables in raceways except as follows:
      a. Within equipment and associated control enclosures.
      b. In accessible ceiling spaces where open cable installation method may be used.
   2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:
   2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.

5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.


11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.

12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

13. Provide strain relief.


15. Do not bend cables in a radius less than 10 times the cable OD.

16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:


2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.

2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.
3.14 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-D, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

A. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."
B. Identify system electrical components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
   1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
   2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
      a. First Visit: Kick-off meeting.
      b. Second Visit: At approximately 25 percent completion of system(s).
      c. Third Visit: Final inspection before system startup.
   3. Kick-off Meeting:
      a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
      b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
      c. Meeting shall cover the following as a minimum requirement:
1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.

2) Manufacturer's installation requirements specific to systems being installed.

3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.

4) Required field activities related installation of VRF HVAC system.

5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:
   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
   d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
   e. Issue a report for each visit, documenting the visit.
      1) Report to include name and contact information of individual making the visit.
      2) Date(s) and time frames while on-site.
      3) Names and contact information of people meeting with while on-site.
      4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:
   a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
   b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
   c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
   d. Inspection reports for indoor units shall include, but not be limited to, the following:
      1) Unit designation on Drawings.
      2) Manufacturer model number.
      3) Serial number.
      4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:
   1) Unit designation on Drawings.
   2) Manufacturer model number.
   3) Serial number.
   4) Network address, if applicable.
   5) Each equipment setting.
   6) Mounting, supports, and restraints properly installed.
   7) Proper service clearance provided.
   8) Wiring and power connections correct.
   9) Line-voltage reading(s) within acceptable range.
  10) Wiring and controls connections correct.
  11) Low-voltage reading(s) within an acceptable range.
  12) Condensate removal acceptable.
  13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:
1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity readings.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Automatic dampers properly installed and operating.
22) Ductwork properly connected.
23) If applicable, external interlocks properly connected.
24) Remarks.

g. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

h. Installer shall correct observed deficiencies found by the inspection.

i. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

j. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
k. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than $1.5 \times$ VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.

4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.

4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:

5. Submit test reports for Project record.

6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:
   1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
   2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
   3. System refrigerant charging shall be witnessed by system manufacturer's representative.
   4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
   1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
   2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:
   1. Check control communications of equipment and each operating component in system(s).
   2. Check each indoor unit's response to demand for cooling and heating.
   3. Check each indoor unit's response to changes in airflow settings.
   4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
   5. Check sound levels of each indoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
   1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:
   1. After completion of startup service, manufacturer shall issue a report for each separate system.
   2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
   3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
      a. All available system operating parameters shall be included in the information submitted.

3.19 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.20 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.21 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months’ full maintenance by manufacturer’s authorized service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.

3.22 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.23 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer’s factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:
   1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
   2. Instructor’s credentials shall be submitted for review by Architect before scheduling training.
   3. Instructor(s) job responsibility shall be Owner training.
   4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.

C. Schedule and Duration:
   1. Schedule training with Owner at least 20 business days before first training session.
   2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one-hour lunch period and 15-minute break after every two hours of training.
5. Perform not less than **eight** total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume three people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.
   1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain **Commissioning Agent** written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 23 81 29
SECTION 23 8213 - RADIANT HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section Includes:
   1. Hydronic radiant heating panels.
   2. Electric radiant heaters.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment.
   2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which heaters and suspension systems will be attached.
   3. Size and location of initial access modules for acoustical tile.
   4. Items penetrating finished ceiling, including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

5. Perimeter moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric radiant heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 HYDRONIC RADIANT HEATING PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aero Tech Mfg.
   2. AIRTEX Radiant Systems.

B. Description: Linear or Modular sheet-metal panel with serpentine water piping, suitable for lay-in installation flush with T-bar ceiling grid or surface mounting.
   1. Panels: Fluted extruded aluminum, approximately 0.115 inches thick. Furnish blank filler pieces at corners and other locations required to form a continuous line.
   2. Backing Insulation: Minimum 2-inch- thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.
   3. Exposed-Side Panel Finish: Baked-enamel finish in manufacturer’s standard paint color as selected by Architect.
   5. Surface-Mounted Trim: Sheet metal with baked-enamel finish in manufacturer’s standard paint color as selected by Architect.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiant heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping connections to verify actual locations before radiant heating and cooling unit installation.

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

3.2 INSTALLATION

A. Install radiant heating units level and plumb.

B. Suspend radiant heaters from structure.

C. Coordinate layout and installation of radiant heaters and suspension-system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communications system, security system, and partition assemblies.

D. Support for Radiant Heating Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support-system rods or wires for each panel. Locate not more than 6 inches from panel corners.
   2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
   3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans, or center in acoustical panel and support panels independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 "Hydronic Piping" and Division 23 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

C. Install piping adjacent to unit to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.

B. Remove and replace malfunctioning units and retest as specified above.

C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain radiant heaters and panels. See Division 01 Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 82 13
SECTION 23 82 16 - AIR COILS AND DRAIN PANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes hydronic heating and cooling air coils.
   1. Refrigerant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.
1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   2. Comply with ASHRAE 15 for refrigeration system safety.

C. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin.
   2. Carrier Corporation.
   3. Daikin.
   6. Johnson Controls.
   7. Lennox Industries.
   8. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

I. DRAIN PANS
   1. Provide a drain pan under each cooling coil, and where indicated. Provide intermediate drain pans at each level of stacked coils. Drain pans shall capture all condensate from coil
assembly; including pipe header, pipe return bends, upstream run-off, and downstream carryover.


3. Provide rigidly supported, leak tight copper downcomer drains from each intermediate pan to pan below.

4. Above Floor Bottom Pan: Minimum 16 gauge construction. Insulate between pan and floor with 1/2 in. thick flexible closed cell elastomeric insulation. Provide threaded outlet at pan low point.

5. Flexible Closed Cell Elastomeric Drain Pan Insulation: Armacell-Armaflex or equivalent. Composite flame spread / smoke density not to exceed 25/50. Fully adhere to the pan bottom with insulation manufacturer’s recommended adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA’s "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless-steel drain pan under each cooling coil.
   1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
   2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
   3. Extend drain pan upstream and downstream from coil face.
   4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.
F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect refrigerant piping according to Division 23 Section 23 23 00 "Refrigerant Piping."

D. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections with the assistance of a factor-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION 23 82 16
SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
   1. Ducted fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Suspended ceiling components.
   2. Structural members to which fan coil units will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:

      a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

6. Perimeter moldings.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Duct Mounted Filters: Furnish one spare filter for each filter installed (MERV 8)

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - “Construction and Startup.”

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning.”

1.8 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.
1.9  WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Compressor failure.
   b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion.

3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED FAN COIL UNITS

A. Manufacturers:

1. Airtherm.
2. Carrier Corporation.
4. Enviro-Tec; by Johnson Controls.
5. Greenheck Fan Corporation.
6. Trane.
7. Johnson Controls.

B. Fan Coil Unit Configurations: **Row** split.

1. Number of Heating Coils: One with two-pipe system.
2. Number of Cooling Coils: One with **two**-pipe system.

C. Coil Section Insulation: **1/2-inch** thick, glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
D. **Coil Section Insulation:** Insulate coil section according to Division 20 Section 20 07 00 "Mechanical Insulation."

1. **Surface-Burning Characteristics:** Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. **Airstream Surfaces:** Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. **Main Drain Pan:** **Stainless steel.** Fabricate pans and drain connections to comply with ASHRAE 62.1.

F. **Chassis:** Galvanized steel where exposed to moisture, with **baked-enamel finish and removable access panel.**

G. **Cabinets:** Steel with baked-enamel finish in manufacturer's standard paint color.

H. **Filters:** Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

I. **MERV Rating:** 8 when tested according to ASHRAE 52.2.

J. **Indoor Refrigerant Coils:** Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.

K. **Direct-Driven Fans:** Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

L. **Remote condensing units are specified in Division 23 Section 23 62 00 "Packaged Compressor and Condenser Units."**

M. **Control devices and operational sequence are specified in Division 20 Section 20 05 48 "Vibration Controls."**

N. **Basic Unit Controls:**

1. **Control voltage transformer.**
2. **Wall-mounting** thermostat with the following features.
   a. **Heat-cool-off switch.**
   b. **Fan on-auto switch.**
   c. **Fan-speed switch.**
   d. **Automatic** changeover.
   e. **Adjustable deadband.**

3. **Unoccupied-period-override push button.**
4. **Data entry and access port.**
   a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

O. Interface with DDC System for HVAC Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.

P. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install fan coil units level and plumb.
   B. Install fan coil units to comply with NFPA 90A.
   C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
   D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS
   A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
      1. Install piping adjacent to machine to allow service and maintenance.
      2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
      3. Connect condensate drain to indirect waste.
         a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Division 23 Section 23 33 00 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

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

END OF SECTION 23 82 19
SECTION 23 82 36 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes hydronic finned-tube radiation heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Include details and dimensions of custom-fabricated enclosures.

3. Indicate location and size of each field connection.

4. Indicate location and arrangement of piping valves and specialties.

5. Indicate location and arrangement of integral controls.

6. Include enclosure joints, corner pieces, access doors, and other accessories.

7. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.

2. Method of attaching finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Modine.
   2. Rittling.
   3. Slant/Fin Corp.
   4. Sterling Hydronics.
   5. Trane.
   6. Vulcan Radiator.

B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled.

D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

E. Front Panel: Minimum 0.0528-inch thick steel.

F. Wall-Mounted Back Panel: Minimum 0.0329-inch thick steel, full height, with full-length channel support for front panel without exposed fasteners.

G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

H. Finish: Baked -enamel finish in manufacturer's standard color as selected by Architect.

I. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

J. Enclosure Style: Double Slope or Flat top.
   1. Top Outlet Grille: Punched louver; painted to match enclosure.
   2. Bottom Outlet Grille (For double slope enclosure): Punched louver; painted to match enclosure.

K. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."

D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.
3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 82 36
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluorethylene plastic.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include location and size of each field connection.
   3. Include details of anchorages and attachments to structure and to supported equipment.
   4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hot Water Cabinet Unit Heater Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm.
   2. Carrier Corporation.
   3. Modine.
   4. Rittling.
   5. Sterling.
   6. Trane.
   7. Vulcan Radiator.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.
2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 COIL SECTION INSULATION

A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing coating to prevent erosion of glass fibers.

1. Thickness: 1/2 inch
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Extended Piping Compartment: 8-inch- wide piping end pocket if indicated on plans
6. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

2.6 FILTERS

A. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.

2.7 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
2.8 CONTROLS

A. Fan and Motor Board: Removable.
   1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermostatic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Division 23 Section 23 09 00 “Instrumentation and Control for HVAC” and on the drawings.

C. Basic Unit Controls:
   1. Control voltage transformer.
   2. Data entry and access port.
      a. Input data includes room temperature and occupied and unoccupied periods.
      b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

D. Interface with DDC System for HVAC Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at central workstation.
   3. Interface shall be BAC-net compatible for central BAS workstation and include the following functions:
      a. Adjust set points.
      b. Cabinet unit-heater start, stop, and operating status.
      c. Data inquiry, including supply-air and room-air temperature.
      d. Occupied and unoccupied schedules.

E. Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping connections to verify actual locations before unit-heater installation.
C. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section 07 92 00 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers.

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:
   1. Division 23 Section 23 21 13 "Hydronic Piping."
   2. Division 23 Section 23 21 16 "Hydronic Piping Specialties."

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section 23 33 00 "Air Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Division 23 Section 23 21 13 "Hydronic Piping."

G. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 23 82 39
SECTION 23 82 39 19 - WALL AND CEILING ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Division 20, Common Work Results for Mechanical, requirements apply to this section.
   C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.
   D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY
   A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   B. Shop Drawings:
      1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      2. Include details of anchorages and attachments to structure and to supported equipment.
      3. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berko; Marley Engineered Products.
   2. Chromalox.
   3. Indeeco.
   5. Marley Engineered Products.
   6. QMark; Marley Engineered Products.
   7. Trane.

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Extruded-aluminum pencil proof bar grille, with removable panels fastened with tamperproof fasteners.

B. Finish: Epoxy/polyester powder with manufacturer’s standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Surface mounting box accessory. Steel with finish to match cabinet.

2.4 COIL

2.5 FAN AND MOTOR
   A. Fan: Aluminum propeller directly connected to motor.
   B. Motor: Permanently lubricated. Comply with requirements in Division 20 Section 20.05.13 "Common Motor Requirements for Mechanical Equipment."

2.6 CONTROLS
   A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
   B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install wall and ceiling unit heaters to comply with NFPA 90A.
   B. Install wall and ceiling unit heaters level and plumb.
   C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
   D. Ground equipment according to Division 26 Section 26.05.26 "Grounding and Bonding for Electrical Systems."
   E. Connect wiring according to Division 26 Section 26.05.19 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 41
SECTION 23 82 40 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 20, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 01 31 00 Project Management and Coordination, applies to this section and will require the contractors’ participation in the Above Ceiling Coordination Program.

D. Division 01 Section 01 91 13 General Commissioning Requirements, applies to this section and will require the contractors’ participation in the commissioning process.

1.2 SUMMARY

A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Include details of anchorages and attachments to structure and to supported equipment.

3. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

4. Indicate location and arrangement of piping valves and specialties.

5. Indicate location and arrangement of integral controls.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hot Water Unit Heater Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Daikin Applied.
   2. Modine.
   3. Reznor.
   4. Rittling.
   5. Sterling.
   6. Trane.
   7. Vulcan Radiator.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical or horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed Comply with requirements in Division 20 "Common Motor Requirements for Mechanical Equipment."

2.7 CONTROLS

A. Control Devices:
   1. Low Voltage relay with transformer for connection to BMS.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping connections to verify actual locations before unit-heater installation.
C. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers

D. Hanger rods and attachments to structure are specified in Division 20 "Hangers and Supports."

E. Vibration hangers are specified in Division 20 Section 20 05 48 "Vibration Controls."

F. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:
   1. Division 23 Section 23 21 13 "Hydronic Piping."
   2. Division 23 Section 23 21 16 "Hydronic Piping Specialties."

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties."

F. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 23 82 40
SECTION 26 0010 - GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 01, Commissioning Requirements, applies to this section and will require the contractor participation in the commissioning process.

C. Division 01 Section “LEED Requirements.”

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical systems provided under CSI Divisions 26, 27 and 28. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Divisions 26, 27 and 28 Specification sections and as indicated on Drawings.

B. Codes and Standards: Perform all Work in accordance with applicable Federal, State and local codes rules, ordinances and regulations. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standards, Rules and Regulations of NFPA, NECA, UL, and as follows unless otherwise indicated.

1. A.N.S.I. - American National Standards Institute
2. A.S.T.M. - American Society for Testing Materials
3. I.C.E.A. - Insulated Cable Engineers Association
4. I.E.E.E. - Institute of Electrical and Electronics Engineers
5. N.E.C. - National Electrical Code
6. N.E.C.A. - National Electrical Contractors Association
7. N.E.M.A. - National Electrical Manufacturer's Association
8. U.L. - Underwriters Laboratories, Inc.


C. Where available products included in the work shall be “Listed”, as defined in article 100 of the NEC, by a nationally recognized testing laboratory. The listing shall be acceptable to the authority having jurisdiction. The listing shall indicate that the product’s safety-related standards have been evaluated with regard to all reasonably foreseeable safety-related hazards, including fire, electrical shock and mechanical hazards.

D. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

E. All materials shall be new unless indicated otherwise to reuse existing equipment.

F. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

G. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

H. Performance Requirements: Perform all work following practices for good workmanship, in accordance with the latest accepted standards and practices for the trades involved.

I. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.

1.4 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor.

B. Rules of local utility companies shall be complied with. Coordinate with the utility companies supplying service to the installation and determine all required interface devices, including the following, and include the cost of all such items and all utilities costs in proposal. Including.

1. All current and potential transformers,

2. Meter boxes,

3. C.T. cabinets and meters which will be required.

4. Surge protection,

5. Raceway sizes,
6. Connection points.

C. Prepare any detailed Drawings or diagrams which may be required by the governing authorities or authorities having jurisdiction. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.5 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.6 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided;

1. Shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation,

2. Shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified,

3. Shall be compatible with the other components of the system,
4. Shall be by the same manufacturer, and

5. Shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications.

All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, mechanical work, controls work, technology work and building alterations shall be included in the original Bid.

1.7 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.8 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.

2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.
1.9 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

D. Submit for approval shop drawings for all electrical systems and equipment as listed below. Where items are referred to by symbolic designation on the Drawings and in the Specifications, all submittals shall bear a similar designation (light fixtures, wiring devices, etc.) as identified on the Drawings and in the Specifications and shall be submitted together and under the same cover, unless requested otherwise. Refer to other sections of the electrical Specifications for additional requirements.

1. Wiring Devices
2. Lighting Control Devices
3. Electrical Power Monitoring and Control
4. Enclosed Controllers
5. Switchboards
6. Panelboards
7. Dry Type Transformers (600 V and Less)
8. Labeling Concept List
9. Interior Lighting
10. Dimming Controls
11. Exterior Lighting
12. Fire Alarm

1.10 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.11 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form.
Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:

1. Routine maintenance procedures.
2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
3. Trouble-shooting procedures.
4. Contractor's telephone numbers for warranty repair service.
5. Submittals.
6. Recommended spare parts lists.
7. Names and telephone numbers of major material suppliers and subcontractors.
8. System schematic drawings on 8-1/2" x 11" sheets.

1.12 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 1.

B. Contractor shall submit to the Architect/Engineer, record drawings in portable device format which have been neatly marked to represent as-built conditions for all new electrical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.13 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.
D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.14 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26, 27 or 28 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. Contractor shall be responsible for any and all temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.15 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner’s consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.16 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items. If mounting heights are not indicated, install to provide maximum possible physical space for access after installation without adding a hazardous situation. Contact the Architect for direction.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures and associated conduit and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work. Remove abandoned wire and cable. Remove abandoned raceways unless removal will require extensive building wall or structure removal which was not part of the work. Abandoned raceways to remain shall be left in a safe and finished condition.
B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

E. Appropriately reroute lighting, power and technology wiring as required to maintain service to equipment and devices to remain. Where walls and ceilings are to be removed, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be safely removed. Plug the ends of conduits which cannot be removed and cannot be reused.

F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.

G. All electrical work in altered and unaltered areas shall be run concealed in finished spaces. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.

H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, re-lamped and reconditioned suitable for satisfactory operation and appearance.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Prior to rough in, allow for flexibility, ten feet in any direction, in the final location of electrical system and wiring devices without additional cost to the Owner.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is
started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage at Contractor's expense.

C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.5 TEMPORARY SERVICES

A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, complete temporary electrical and telecommunication (voice/data) services for use during construction.

3.6 DISPOSAL

A. Fluorescent Lamps

1. Fluorescent lamps are known to contain mercury and are classified as hazardous material. All fluorescent lamps shall be assumed to contain mercury unless tested and confirmed otherwise with a toxicity characteristic leaching procedure (TCLP).

2. Hazardous materials, including fluorescent lamps, shall be sent to a lamp recycling facility. The materials shall be properly packaged with labels that meet the Department of Transportation Regulations and stored in a secure location prior to transportation.

3. The Contractor shall identify the costs of the lamp disposal process including, but not limited to, the lamp packaging, storage, transportation, disposal, and any profile fees.

4. At the completion of the project, provide documentation to verify that the lamps have been properly disposed of in accordance with all local, state and federal guidelines.

B. Ballasts

1. Lighting ballasts manufactured prior to 1979 have been known to contain polychlorinated biphenyls (PCBs). Unless specifically noted on the ballast as containing "No PCBs," the ballast shall be assumed to contain components with PCB materials.
2. Hazardous materials (ballasts with PCBs), shall be disposed of at a hazardous waste incineration facility, or at a recycling facility in accordance with the Code of Federal Regulations as administered by the EPA in regards to this issue. The ballasts shall be packaged/stored in fifty-five gallon steel drums with labels that meet the Department of Transportation Regulations.

3. The Contractor shall identify the costs of the ballast disposal process including, but not limited to, the packaging, storage, transportation, disposal, and any profile fees.

4. Provide at completion of the project documentation (manifests) to verify that the ballasts have properly been disposed of in accordance with all local, state and federal guidelines.

3.7 ACCESS DOORS, CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.8 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.9 EXCAVATION AND BACKFILLING

A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.

C. Backfill all excavations, away from wall footings, with well-tamped granular material.

1. Place granular backfill in layers not more than 8 inches in thickness, Compact each layer to 95 percent, Excavated material shall not be used.

2. Outside building, first place granular material, as indicated above, up to 12 inches over top of pipe. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

D. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing.
3.10 EQUIPMENT CONNECTIONS

A. As included in the work, make connections to equipment, motors, elevator controllers and associated equipment, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.11 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.12 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.13 EXTRA WORK

A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. Proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done. Prior to any extra work which may be proposed, submit unit prices (same prices for increase/decrease of work) for the following items:

1. 1/2", 3/4", 1", 1-1/2" conduit;

2. #12, #10, #8, #6, #2 wire;

3. Receptacles,

4. GFCI receptacle,

5. Data or network box,
6. Fire alarm devices,
7. Clock.
8. Light Fixtures by type.
9. Motor control devices

3.14 DRAWINGS AND MEASUREMENTS

A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if called for by both. The Contractor understands that the work herein described shall be complete in every detail.

B. The Drawings are not intended to be scaled for rough-in measurements or to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 0010
SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 COORDINATION

A. Owner/Trade Supervisor shall be included in all State of Michigan inspections. If Owner is not present at inspection, Construction Manager shall schedule another meeting where Owner is present.
   1. The Owner Reserves the right to direct rearrangement and/or replacement of any item or part of the work that in their opinion, does not represent a neat, orderly, workmanlike installation so that it complies with State of Michigan Electrical Code.
   2. Such rearrangement and/or replacement, when so directed, shall be made at the contractor’s expense with no additional cost to the Owner.

B. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
2.3 GROUT

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

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 26 0500
SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multi-conductor cables, cable splices, and terminations for electrical distribution systems with 2,001 to 35,000 V.
2. Division 26 Section "Under Carpet Electrical Power Cables" for flat cables for under carpet installations.
3. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. General Cable Corporation.
   2. Senator Wire & Cable Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW, and SO.

D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC and Type SO with ground wire. Metal-clad cable armor shall be steel.

E. Fire-resistive Cable: Comply with NEMA WC 70. Cable shall be UL labeled as 2-hour fire-rated, type MI mineral-insulated with nickel-clad copper conductor, magnesium oxide insulation, copper alloy sheath, and rated 600 volts. Provide factory installed terminations or field termination kits from the same manufacturer as the cable.
   1. Pentair Pyrotenax
   2. In lieu of the mineral-insulated cable above, a 2-hour fire rated metal clad cable may be substituted. Provide RSCC & Cable VITALink.

F. VFD Cable
   1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
   2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. Thomas & Betts

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material type, and class for application and service indicated.

C. Push in connectors shall not be provide.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Stranded.
   1. Feeder Circuits: Unless specifically noted on the drawings, copper conductors shall be used. For circuits #1AWG and larger, Aluminum conductors may be used (excluding mechanical equipment circuits).
   2. Branch Circuits: Unless specifically noted on the drawings, copper conductors shall be used. For circuits #1AWG and larger, Aluminum conductors may be used (excluding mechanical equipment circuits).
   3. Unless indicated otherwise, solid for conductors #10AWG and smaller, stranded for conductors #8AWG and larger

B. Equipment circuits shall be copper, where required by manufacturer's recommendations or direction.

C. Minimum Conductor Sizes:
   1. Feeders and Branch Circuits: No. 12 AWG.
   2. Class 1 Control Circuits: No. 14 AWG.
   3. Class 2 Control Circuits: No. 16 AWG.

D. Unless indicated otherwise, power circuits shall be 2#12, 1#12G, ¾"C.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN or Type XHHW single conductors in raceway.
B. Fire Pump Service Entrance: Type THHN-THWN or Type XHHW, single conductors in raceway, installed below floor slab or installed in at least 3 inches of concrete, or 2-hour fire-resistant cable.

C. Emergency Feeder Circuits: Type THHN-THWN or Type XHHW, single conductors in raceway, installed below floor slab, installed in fully sprinkled spaces or installed in a minimum 2-hour fire rated system or shall be a 2-hour fire-resistant cable system.

D. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

E. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

F. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or Type XHHW, single conductors in raceway.

G. Feeders installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

H. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Inaccessible Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits in Accessible Ceiling Spaces:
   1. Type THHN-THWN, single conductors in raceways, or
   2. Type MC Cable in lengths 6'-0" or less and for use as a master slave connection between light fixtures.
   3. Type MC Cable can be used within a room/space, to each wiring device in that space. The branch circuit shall be single conductors in raceway from the source panel to the room/space.

K. Branch Circuits Gypsum-Board Partitions: Type THHN-THWN, single conductors in raceways, or Metal-clad cable, Type MC for vertical drops to outlet boxes. MC shall not be used for switch box connections or installed horizontally between boxes.

L. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

M. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

N. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

O. Class 1 Control Circuits: Type THHN-THWN, in raceway.
P. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes (not allowed in exposed ceiling of finished spaces), or Power-limited tray cable, in cable tray.

Q. Motor branch circuits, which include a variable frequency drive (VFD): Provide VFD cable from the source overcurrent protection device to the motor. Shields shall be maintained electrically continuous and shall be terminated to the building ground system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. For circuits that require a neutral conductor, provide a dedicated neutral back to the panelboard.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.

D. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

E. Do not install conductors supplied from different panelboards, distribution panels, or switchboards in same conduit or raceway, unless otherwise noted.

F. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

G. Install cables parallel and perpendicular to surfaces of structural members, and follow surface contours where possible.

H. Do not route cables directly through panelboards, switchboards, motor starting equipment and similar equipment, as part of the cable pathway.

I. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors and feeder conductors for compliance with requirements.

2. Perform each electrical, visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification, including but not limited to the following:
   a. Bolted connection resistance,
   b. Insulation resistance with respect to ground and adjacent conductors,
   c. Continuity verification,
   d. Phase verification,
   e. Resistance of parallel conductors.

3. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

3.7 VOLTAGE DROP

A. Voltage drop shall not exceed two percent for feeder conductors.

B. Voltage drop shall not exceed three percent for branch conductors. Refer to table below for maximum permitted branch conductor lengths at rated voltages for indicated OCP. Where lengths are exceeded due to revised routing, calculate the voltage drop and provide the appropriate conductor size to achieve the maximum allowable voltage drop.

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>#12 AWG</th>
<th>#10 AWG</th>
<th>#10 AWG</th>
<th>#8 AWG</th>
<th>#6 AWG</th>
</tr>
</thead>
</table>

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

26 0519 - 6
<table>
<thead>
<tr>
<th>Voltage Configuration</th>
<th>20 amp OCP</th>
<th>20 amp OCP</th>
<th>30 amp OCP</th>
<th>40 amp OCP</th>
<th>50 amp OCP</th>
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<tbody>
<tr>
<td>120V, single phase</td>
<td>56 feet</td>
<td>93 feet</td>
<td>62 feet</td>
<td>72 feet</td>
<td>91 feet</td>
</tr>
<tr>
<td>208V, single phase</td>
<td>97 feet</td>
<td>162 feet</td>
<td>108 feet</td>
<td>124 feet</td>
<td>159 feet</td>
</tr>
<tr>
<td>240V, single phase</td>
<td>112 feet</td>
<td>187 feet</td>
<td>125 feet</td>
<td>144 feet</td>
<td>183 feet</td>
</tr>
<tr>
<td>277V, single phase</td>
<td>129 feet</td>
<td>216 feet</td>
<td>144 feet</td>
<td>166 feet</td>
<td>211 feet</td>
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<tr>
<td>480V, single phase</td>
<td>225 feet</td>
<td>374 feet</td>
<td>249 feet</td>
<td>288 feet</td>
<td>367 feet</td>
</tr>
<tr>
<td>208V, three phase</td>
<td>112 feet</td>
<td>187 feet</td>
<td>100 feet</td>
<td>115 feet</td>
<td>133 feet</td>
</tr>
<tr>
<td>240V, three phase</td>
<td>103 feet</td>
<td>173 feet</td>
<td>125 feet</td>
<td>144 feet</td>
<td>183 feet</td>
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<tr>
<td>480V, three phase</td>
<td>259 feet</td>
<td>433 feet</td>
<td>288 feet</td>
<td>333 feet</td>
<td>424 feet</td>
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Note: Table assumptions include copper conductors at 80% load capacity, 1.0 power factor, 75°C temperature rating, EMT conduit, and three percent voltage drop.
SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment plus the following special applications:
   1. Underground distribution grounding.

1.3 SUBMITTALS

A. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Ground rings.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated (green) for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Conductors buried in concrete shall have RHW or THW insulation.

D. Grounding Bus: Rectangular bars of annealed copper, 24"L by 1/4"D by 2"H, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Manufacturers:
   1. Thomas & Betts
   2. Burndy

B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Compression Connectors: Irreversible, factory filled with an oxide inhibitor. Connectors must comply with IEEE837, UL467 and CSA22.2

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: stranded unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, in MDF and IDF rooms, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
   3. Provide No. 3/0 AWG minimum insulated copper grounding conductor in raceway from grounding bus to neutral bus service entrance equipment.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground or Encased in Concrete Connections: exothermic welds, except at test wells and as otherwise indicated.
   3. Aboveground and exposed: Welded or compression connectors except at test wells and as otherwise indicated.
   4. Connections to Ground Rods at Test Wells: Bolted connectors.
   5. Connections to Structural Steel: Welded connectors.
   6. Compression connectors shall be installed with the same manufactures die so that the die index matches the listed index on the connector. Connector must be fully crimped with a 14 ton or larger hydraulic tool so that the index number is indented on the connector.

E. Ground-Rod Connections: Install exothermic connections for underground connections and connections to rods.

F. Lightning Arrestor Grounding Conductors: Separate from other grounding conductors.

G. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and
fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from foundation.

E. Pad-Mounted Generators: Install two ground rods and ground ring around the pad. Ground generator housing and noncurrent-carrying metal items associated with generator by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Signal and Communication Equipment: For telephone, alarm, voice and data equipment rooms, MDF and IDF rooms, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in a conduit.

C. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Use exothermic-welded connections without exposing steel or damaging coating, if any.
   2. For grounding electrode system, install at least three rods, unless documented otherwise, spaced at least one-rod length from each other and located at least the same distance for other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section “Underground Ducts and Raceways for Electrical Systems” and shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Wiring Devices:
   1. Install a 6 inch (150mm) green insulated pigtail from grounding terminal of wiring device to device box and equipment grounding conductor.
   2. For lighting fixtures, install insulated grounding conductor and terminate to terminal on lighting fixture housing.
   3. For electric motors, install an insulated equipment grounding conductor in branch circuit serving each electric motors, and bond to motor frame.

G. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

H. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart. Install tinned-copper conductor not less than No. 2/0 AWG for tap to building steel.

J. Structural Steel and Catwalks: Provide braided bonding jumpers at building expansion joints to make building steel electrically continuous. Bond catwalks to building steel with braided bonding jumpers. Terminate bonding jumpers with exothermic welds.

K. Transformer Secondary Neutrals:
   1. Provide No. 2 AWG minimum insulated copper grounding conductor, in raceway from grounding electrode system to transformer housing. Terminate to transformer XO connection.
   2. Provide No. 3/0 minimum insulated copper grounding electrode conductor from transformer XO connection to building steel. Exothermically weld to building steel.
   3. Looping grounding conductors from transformer to transformer shall not be allowed.

L. Cable Tray: Provide bonding jumpers to make cable tray electrically continuous throughout. Provide No. 4 AWG minimum insulated copper grounding conductor in raceway from grounding electrode system to cable tray system, bonded to cable tray.

M. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

N. Counterpoise Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building foundation.
O. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526
SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS 26 0529 - 1
PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems (Adjustable and Fixed Length): Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16 inch-diameter holes at a maximum of 8 inches o.c. in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube and Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1, NECA 101, and the NEC for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where it’s Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with clamps approved for the application by an agency acceptable to the authorities having jurisdiction.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
F. Adjustable length slotted steel supports shall be clamped to a fixed length, per manufacturer’s instructions to maintain weight support restrictions recommended by the manufacturer.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section “Metal Fabrications” for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

   1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529
SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
A. Shop Drawings: For the following raceway components, include plans, elevations, sections, details and attachments to other work:
   1. Custom enclosures and cabinets.

1.5 COORDINATION
A. Create Coordination Drawings for use in raceway installation.
   1. Create conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Structural members in the paths of conduit groups with common supports.
b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

B. Source quality-control test reports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work limited to, the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamest Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
7. Maverick Tube Corporation.
10. Thomas & Betts

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.
I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

2. Fittings for EMT: set screw except in wet locations where rain tight compression type shall be used.
3. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with the provided raceways as required for complete system.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Thomas & Betts; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
1. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with the provided raceways as required for complete system.

2.3 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Legrand Cablofil
4. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 indoors NEMA Type 3R in wet or damp locations and outdoors, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Small sizes (4 inches by 4 inches and smaller) shall be hinged type with fastening device. Larger sizes shall be provided with a screw-cover and gasket.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

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

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Fittings and Accessories: Include 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.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Legrand Wiremold
   b. Panduit Corp

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Incorporated; Wiring Device-Kellems Division.
   b. Lamson & Sessions; Carlon Electrical Products.
   c. Panduit Corp.
   d. Legrand Wiremold
2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
7. RACO; a Hubbell Company.
9. Spring City Electrical Manufacturing Company.
10. Thomas & Betts Corporation.
11. Legrand Wiremold

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1, one piece cold drawn type, welded boxes are not acceptable.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes, Covers and Box Supports: NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, with gasketed cover.

G. Dividers: Provide listed dividers inside multi-gang boxes where required to separate phases.

H. Metal barriers to separate wiring of different systems and voltages exceeding 150V.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated:

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit, IMC, or RNC, Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, or RNC, Type EPC-40-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: Rigid steel conduit, IMC or EMT.
2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
3. Concealed in Ceilings and Interior Walls and Partitions: Rigid steel conduit, IMC or EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit or IMC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: [Plenum-type, optical fiber/communications cable raceway] [EMT]. Conduit ends shall be provided plastic bushings.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: [Riser-type, optical fiber/communications cable raceway] [EMT]. Conduit ends shall be provided plastic bushings.
9. Raceways for Concealed General-Purpose Distribution of Optical Fiber or Communications Cable: EMT unless noted otherwise. Conduit ends shall be provided plastic bushings. Unless otherwise noted or indicated by the manufacturer's installation instructions, provide rigid steel conduit or IMC for all load-side power feeders, line-side power feeders, or control conduits for variable frequency drives or variable speed drives.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
E. Do not install aluminum conduits in contact with concrete.

F. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

G. Conduits shall be routed inside the building, in lieu of exposed across the roof, unless indicated otherwise.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 8 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Install raceways parallel to building lines.

D. Install raceway expansion fittings at building expansion joints parallel to building lines.

E. Complete raceway installation before starting conductor installation.

F. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

G. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

J. Raceways Embedded in Slabs:
   1. Conduits embedded in slabs shall not be larger than 1-inch diameter. Multiple parallel embedded conduits shall be spaced a minimum of 4-inches on center.
   2. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Provide insulating and grounding bushings at junction boxes, outlet boxes, and cabinets for conduits one-inch and larger in diameter.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
O. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
4. Conduit ends shall be provided plastic bushings.

P. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

Q. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg. F, and that has straight-run length that exceeds 25 feet.

1. Install-expansion joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location.

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degree F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 degree F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 degree F temperature change.
   d. Attics: 135 degree F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight-run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at the time of installation.

R. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 31 Section "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing planks 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Refer to Specification 26 0500 “Common Work Results for Electrical” for sleeve and sleeve-seal installation instructions.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Coordinate installation of PVC coated conduit with factory authorized representative.
   3. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 0533
SECTION 26 0536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes cable trays and accessories.

1.3 SUBMITTALS
   A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
   B. Shop Drawings: For each type of cable tray.
      1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   C. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
   A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Cable tray shall be stored indoors. Protect cable tray from scratching and marring of finish. Unpack and dry wet materials before storage.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Cooper B-Line, Inc.
3. WB Tray.
4. MPHusky.
5. Legrand

2.2 MATERIALS AND FINISHES

A. Sizes and Configurations: Cable Trays shall be wire basket with NEMA Class 12B load rating. Minimum tray depth shall be 4”. Refer to Drawing Notes for specific requirements for sizes and configurations.

1. Use trapeze style hangers recommended by the manufacturer. Center-hanger or bracket supports shall not be used.
2. Wire Basket wire mesh diameter - Minimum to meet requirements as specified including loading and grounding.

B. Cable Trays, Fittings, and Accessories: Complying with NEMA VE 1, or NEMA FG1.

2. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, ASTM F 1136, hardware.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."
2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure.
   1. Design each fastener and support to carry load per manufacturer’s instructions.
   2. Place supports so that spans do not exceed maximum ratings. Derate load ratings to compensate for ambient temperature per the manufacturer’s recommendations.
   3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
   4. Support bus assembly to prevent twisting from eccentric loading.
   5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
   6. Locate and install supports according to NEMA VE 2.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Where the cable tray is penetrating fire rated partitions provide EZ Path fire rated penetration system through fire and smoke barriers as indicated on the drawings.

I. Workspace: Install cable trays with enough space to permit access for installing cables.

J. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.
3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. Provide a #6 AWG minimum ground connection between separated cable tray sections and at one IDF or MDF ground bus.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.

2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.

3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.

4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.

5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray. Test entire cable tray system for adequate bonding; the maximum allowable resistance shall be 1 ohm.

B. Report results in writing.

3.5 PROTECTION

A. Protect installed cable trays.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

END OF SECTION 26 0536
SECTION 26 0543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks and in single duct runs.
      2. Handholes and boxes.

1.3 DEFINITION
   A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
   A. Qualification Data: For professional engineer and testing agency.
   B. Source quality-control test reports.
   C. Field quality-control test reports.

1.5 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
   B. Comply with ANSI C2.
   C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

   1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager’s written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into manholes, handholes and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT


B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

   1. ARNCO Corp.
   2. Beck Manufacturing.
   3. Cantex, Inc.
7. Lamson & Sessions; Carlon Electrical Products.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section “Identification for Electrical Systems.”

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Advance Concrete Products Company
2. Carder Concrete Products.
3. Christy Concrete Products.
4. Elmhurst-Chicago Stone Co.
5. Oldcastle Precast Group.
6. Riverton Concrete Product; a division of Cretex Companies, Inc.
7. Utility Concrete Products, LLC.
8. Utility Vault Co.
9. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
4. Frame and Cover: Weatherproof aluminum frame with hinges aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover handle; Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, “ELECTRIC”.
7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors or frames and cover of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDBOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with ANSI/SCTE 77.

2. Configuration: Units shall be designed for flush burial and have open bottom; unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering. "ELECTRIC".
7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
8. There shall be no splices in Hand Holes.
9. There shall be no Hand Holes installed where subject to vehicular or pedestrian traffic including sidewalks.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. Hubbell Power Systems, Quazite.
2.5 PRECAST MANHOLES

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

1. Advance Concrete Products Company
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Structural Loading: AASHTO HB 17; Heavy or Medium Vehicles, H-20.

D. Duct Entrances in Manhole walls: Cast bell-end or duct terminating fitting for each entering duct.

E. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

F. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 UTILITY STRUCTURE ACCESSORIES

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

1. Advance Concrete Products Company
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
8. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50
      b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   2. Cover Legend: Cast in. Selected to suit system.
      a. Legend: “ELECTRIC” for duct systems with power wires and cables for systems operating at 600 V and less.
      b. Legend: “ELECTRIC” for duct systems with medium-voltage cables.
      c. Legend: “SIGNAL” for communications, data, and telephone duct systems.
      d. Manhole designation shall be welded to the top of the cover.
   3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
      a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.


D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1x4-inch bolt
   1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1 ¼ inch-diameter eye, rated 2500-lbf minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8 inch diameter, hot-dip galvanized, bent steel rod, stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2 -inch ID by 2 ¾ inches deep, flared to 1-¼ inches minimum at base.
   1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

H. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with ½ -inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer:

   1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
   2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position.
      a. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity.
      b. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials and common metals.

K. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

L. Cover Hooks: Heavy-duty, designed for lifts 60 lbf or greater. Two required.

M. Portable manhole Ladders: Require UL-listed heavy duty fiberglass ladder designed for portable use for access to manholes. Length shall be equal to the depth of the deepest manhole plus 36 inches.

N. All Manholes for electrical systems shall be damp proofed with bituminous damp proofing.

O. Provide all OSHA required signage inside manhole in addition to a warning sign indicating “Confined Space Hazard”

2.7 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify test by the manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct buried duct bank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables; RNC, NEMA Type EPC-40-PVC, installed in concrete encased duct bank, unless otherwise indicated.

F. Underground Ducts for Telephone, Communications or Data Circuits; RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

G. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and less [Including Telephone, Communications, and Data Wiring]:

1. Units in Roadways and other Deliberate Traffic Paths: Precast concrete. AASTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO BH 17, H-20, Polymer concrete, DCTE 77, Tier 15, Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15, or Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, or Tier 8, Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.

4. Units subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.
3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 18 feet, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Underground conduits that penetrate the building below grade, conduit shall be effectively sealed at the point of penetration below grade by means of conduit sealing bushings of the appropriate type, as manufactured by Polywater FST or approved equal. Sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3-1/2 inches between ducts for like services, and 4 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

10. Tracer cables shall be terminated near the cover to be easily accessible without entering the manhole vault.

I. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor
temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less
than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent
displacement during backfill and yet permit linear duct movement due to expansion and
contraction as temperature changes. Stagger spacers approximately 6 inches between
tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench
bottoms as specified in Division 31 Section “Earth Moving” for pipes less than 6 inches in
nominal diameter.
4. Install backfill as specified in Division 31 Section “Earth Moving”.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward
end of duct run, leaving ducts at end of run free to move with expansion and contraction
as temperature changes during this process. Repeat procedure after placing each tier.
After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly
tamp backfill around ducts to provide maximum supporting strength. Use hand tamper
only. After placing controlled backfill over final tier, make final duct connections at end of
run and complete backfilling with normal compaction as specified in Division 31 Section
“Earth Moving”.
6. Install ducts with a minimum of 3-1/2 inches between ducts for like services and 6 inches
between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise
indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and
at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and
      encase coupling with 3 inches of concrete.
   b. For equipment mounted on outdoor concrete bases, extend steel conduit
      horizontally a minimum of 60 inches from edge of equipment pad or foundation.
      Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches above all direct-buried ducts
    and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.
    Provide an additional warning tape for each 12-inch increment of duct-bank width over a
    nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
11. Tracer cables shall be terminated near the cover to be easily accessible without entering
    the manhole vault

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES AND BOXES

A. Cast-in-Place Manhole Installation:

   1. Finish interior surfaces with a smooth-troweled finish.
   2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to
      2 inches thick, arranged as indicated.
   3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section
      “Cast-in-Place Concrete”.
B. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
   3. Install handholes with bottom below frost line. 42” below grade.
   4. Handhole Covers: In paved areas and trafficways, set surface with finished grade. Set covers of other handholes 1 inch above finished grade.
   5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section “Bituminous Dampproofing”. After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install “Confined Space Hazard” warning sign on the inside surface of each manhole cover.
3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depth of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½-inch sieve to NO. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line. 42” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits, according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving, and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section “Cast-in-Place Concrete” with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.
3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 0543
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Identification for raceway and metal-clad cable.
   2. Identification for conductors and communication and control cable.
   4. Warning labels and signs.
   5. Instruction signs.
   7. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

B. Comply with NFPA 70.

1.4 COORDINATION

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.
E. When identifying room numbers on labels or directories, coordinate with the Owner's final room numbering system, as the architectural room numbers are generally arbitrary and may not be final.
2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.
2.4 WARNING LABELS AND SIGNS


B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. More than 600V Warning: "DANGER – HIGH VOLTAGE – KEEP OUT."
4. 480V Warning: "480 VOLTS."
5. Phase Color-Coding of 208Y/120V panelboards: "PHASE A - BLACK, PHASE B RED, PHASE C BLUE, NEUTRAL WHITE, GROUND GREEN."
6. Phase Color-Coding of 480Y/277V panelboards: "PHASE A - BROWN, PHASE B ORANGE, PHASE C YELLOW, NEUTRAL GRAY, GROUND GREEN."
7. Engraved Plastic Laminate Signs: Use engraved plastic-laminate signs for the identification of all electrical panels, disconnects, motor starters and other equipment.
   a. Signs shall be white background with black lettering.
   b. Provide the following information on each sign:
      1) Equipment or panel designation
      2) Voltage, phase, and number of wires, such as (480/277 3P 4W)
      3) Fed from, such as (FROM PP-1E/12)
   c. Medium voltage equipment will be identified with 5x8 placards using a 3 line format.
      1) Line 1: Codename of the device.
      2) Line 2: Codename of the connected cable.
      3) Line 3: Codename of the device connected on the other end of cable.

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
   1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior concrete and masonry primer.
   2. Exterior Concrete Unit Masonry:
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
         1) Block Filler: Concrete unit masonry block filler.
   3. Exterior Ferrous Metal:
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior ferrous-metal primer.
   4. Exterior Zinc-Coated Metal (except Raceways):
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior zinc-coated metal primer.
   5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Interior concrete and masonry primer.
         2) Finish Coats: Interior Semi-gloss alkyd enamel.
   6. Interior Concrete Unit Masonry:
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
7. Interior Gypsum Board:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior gypsum board primer.
      2) Finish Coats: Interior Semi-gloss acrylic enamel.

8. Interior Ferrous Metal:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior Semi-gloss acrylic enamel.

9. Interior Zinc-Coated Metal (except Raceways):
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior zinc-coated metal primer.
      2) Finish Coats: Interior Semi-gloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with snap-around labels or stenciled legend. Repeat legend at 10-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange snap-around label or stenciled legend adjacent to each junction box, pull box, and electrical enclosure.
D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands, or stenciled legend:

1. Fire Alarm System: Red.
5. Mechanical and Electrical Supervisory System: Green and blue.
7. Control Wiring: Green and red.

E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 4 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape, marker tape, or write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

F. Branch-Circuit Conductor Identification: Use marker tape or write-on tags in each junction or pull box. Identify each ungrounded conductor according to source and circuit number.

G. Conduits to Be Extended in the Future: Attach write-on tags or marker tape to conduits and list source and circuit number.


1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs or metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.
2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
3. Equipment More Than 600 V: Apply to door or cover of equipment including, but not limited to, the following:
   a. Electrical switchgear.
   b. Transformer.
4. Panelboards rated 208Y/120V or 480Y/277V: Apply phase color-code identification label to door or cover of equipment in including the following:
IDENTIFICATION FOR ELECTRICAL SYSTEMS

a. Panelboards.
b. Power Panels.
c. Distribution Panels.
d. Switchboards.

5. Equipment Rated 480 V: Unless otherwise indicated, apply to door or cover of equipment. Apply to inside door or cover of flush panelboards and similar equipment in finished spaces.

6. All power distribution equipment: Apply arc flash labels required by code or other sections of the Specification.

K. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high. For single-gang motor starting switches, use 3/8-inch high letters on 3/4-inch high by 2.25-inch wide label; for two-gang motor starting switches, use 3/8-inch high letters on 3/4-inch high by 4 inch wide label.

b. Outdoor Equipment: Engraved laminated acrylic, melamine label, or stenciled legend 4 inches high.

c. Access panel doors, concealing electrical equipment/devices: machine generated clear label with black 1/2 inch high text.

d. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Electrical substations.
f. Emergency system boxes and enclosures.
g. Motor-control centers.
h. Disconnect switches.
i. Enclosed circuit breakers.
j. Motor starters.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Battery inverter units.
p. Battery racks.
q. Power-inverter units.
r. Master clock and program equipment.
s. Intercommunication and call system master and staff stations.
t. Fire-alarm control panel and annunciators.
u. Monitoring and control equipment.
v. Uninterruptible power supply equipment.

M. Electrical Energy Source Identification Labels: On each unit of equipment, install a unique source and circuit designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manuals. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 3/8-inch high letters on 3/4-inch high label; where 2 lines of text are required, use labels 1.5 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label or stenciled legend.
   c. Light Switching Devices, misc. electrical controlling devices (ie. Shade controllers), Pull and Junction Boxes: Apply source and circuit to back of device box cover and to front of pull and junction box covers with indelible ink.
   d. Receptacle devices: Apply source and circuit to front of device box cover with machine generated clear label and black 1/4 inch high text. Label source and circuit to front of pull and junction box covers with indelible ink.

2. Equipment to be Labeled:
   a. Panelboards.
   b. Electrical switchgear, switchboards, and distribution panels.
   c. Transformers.
   d. Electrical substations.
   e. Emergency system boxes and enclosures.
   f. Motor-control centers.
   g. Disconnect switches.
   h. Enclosed circuit breakers.
   i. Motor starters.
   j. Power transfer equipment.
   k. Contactors.
   l. Central battery inverter units.
   m. Power-generating units.
   n. Technology (voice and data) equipment racks and cabinets.
   o. Master clock and program equipment.
   p. Fire alarm control panel and power supplies.
   q. Security and intrusion-detection control panels.
   r. Uninterruptible power supply equipment.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Where used on electrical equipment and enclosures also use screws to fasten in place.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Fasten signs and labels to electrical equipment and enclosures with screws.

G. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 6 AWG if authorities having jurisdiction permit, field applied.

2. Colors for 208Y/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   e. Ground: Green.

3. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray.
   e. Ground: Green.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

I. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

K. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

L. Branch and Feeder Circuit Load Identification Labels: On each overcurrent protective device, install unique load designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.
   1. Labeling Instructions:
      a. Panelboard Circuit Directories: Provide type-written or laser printed circuit directory on heavy card stock. Arrange in two columns with odd numbered circuits on left and even numbered circuits on right. Include panelboard identification and installation date. Indicate spare circuit breakers: “SPARE”. Install in metal frame with clear plastic cover. Coordinate with the Owner's final room numbering system.
      b. Overcurrent Protective Devices Installed in Distribution Panels and Switchboards: Engraved, laminated acrylic or melamine labels. Unless otherwise indicated, provide a single line of text with 3/8-inch high letters on 3/4-inch high label; where 2 lines of text are required, use labels 1.5 inches high.

M. Independent Support Wire: Where independent support wires are permissible and utilized for securing electrical raceways, cable assemblies, boxes, cabinets, or fittings within ceiling cavities, they shall be distinguishable from ceiling support wires by color, tagging, or other effective means.

END OF SECTION 26 0553
SECTION 26 0573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD STUDIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes computer-based, fault-current, overcurrent protective device coordination, and arc flash hazard studies.
   B. Protective devices shall be set based on results of the protective device coordination study.
      1. Coordination of series-rated devices is permitted where indicated on Drawings.
   C. Electrical equipment shall be labeled with the arc flash hazard information based on the results of the arc flash hazard study.
   D. As much as possible, the overcurrent protective device settings shall be to keep the arc flash hazard at any point in the system no greater than level 2. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

1.3 SUBMITTALS
   A. Product Data: For computer software program to be used for studies.
   B. Study Report
      1. Submit the fault current study report to the Engineer for review, prior to ordering the electrical distribution equipment.
         a. Provide a tabulation document, as part of the submittal, which compares and identifies discrepancies between, the study results and the proposed electrical distribution equipment.
         b. Highlight designed overcurrent protective devices which have interrupting ratings lower than the
            1) Calculated 1/2-cycle symmetrical fault current or the
            2) Calculated 1/2-cycle asymmetrical fault current, as appropriate.
   C. Product Certificates:
      1. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
For arc flash hazard calculations computer software program certifying compliance with IEEE 1584.

D. Qualification Data: For coordination-study and arc flash specialist.

E. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
4. Arc flash hazard level report labels as defined in NFPA 70 and NFPA 70E.

Electronic Program Files
1. Provide the Owner with all software program files created for the Overcurrent Protective Device Coordination and Arc Flash Hazard Study at the end of the project, after all revisions and updates have been incorporated. Provide files on CD or flash drive. Files shall include:
   a. One Line Diagrams created with the software.
   b. Short circuit calculations input data and results.
   c. Source data for each power source used in the calculation including but not limited to:
      1) Utilities,
      2) Generators,
      3) Motors,
      4) DC sources.
   d. Overcurrent protective device coordination input data and results including time current curve data for each device used in the calculation.
   e. Protection curve data for each cable, bus, transformer and electric machine used in the calculation
   f. Arc flash hazard study input data and calculation results
   g. Arc flash hazard labels created, for the project, for each piece of equipment.

2. It shall be assumed that the files provided reflect the calculations of the power distribution system as installed at the point of substantial completion of the project and any power distribution system alterations of the system will require re-evaluation of the system by a qualified engineer.

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 not acceptable.

B. Coordination-Study and Arc Flash Hazard Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash hazard calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. ESA Inc.
3. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

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. The program shall generate signage indicating arc flash data that shall be installed on the equipment.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination and arc flash hazard studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination and arc flash hazard studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination and arc flash hazard studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
   a. Circuit-breaker and fuse-current ratings and types.
   b. Relays and associated power and current transformer ratings and ratios.
   c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   d. Generator kilovolt amperes, size, voltage, and source impedance.
   e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   f. Busway ampacity and impedance.
   g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company’s overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
   h. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in RMS symmetrical amperes at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a
current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Generator terminals and distribution panel.
3. Distribution panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:
   a. ANSI C57.12.22.
   b. ANSI C57.12.40.
   c. IEEE C57.12.00.
   d. IEEE C57.96.

4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY


1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

Selective Coordination: Overcurrent protective devices shall coordinate so that the device closest to the fault operates to clear the fault while leaving upstream devices closed. Where this is not possible the engineer shall be notified prior to ordering the power distribution equipment. Practicalities shall be considered, including:
1. Where selective coordination will cause an increased hazard, discussions with the engineer shall be initiated.
2. Series devices which will not benefit from selective coordination can be ignored.

G. Coordination- Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company’s upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD STUDIES

Detroit Public Schools Community District

Issued for: PERMIT/BID SET

Stantec

Stantec Project Number 214100569

2022.06.21

3.5 ARC FLASH HAZARD CALCULATIONS

A. Perform calculations using an approved computer software program. Prepare signage and install on all equipment as defined by NFPA 70E.

1. Calculate maximum energy available at each location.

2. Indicate required PPE equipment level.

B. Comply with IEEE and NFPA 70E.

C. Provide tabular report indicating the following information at each piece of equipment.

1. Flash Protection Boundary (in inches).

2. System voltage.

3. Hazard Risk Category.


5. Incident Energy level at 18 inches in CAL/CM².

6. Required PPE level and brief description of PPE.


8. Equipment ID.

9. Date.

END OF SECTION 26 0573
SECTION 26 0800 - ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This specification includes the commissioning process requirements for Electrical equipment, systems and assemblies.

B. Refer to Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 SCOPE OF COMMISSIONING

A. The following Electrical systems are to be commissioned:

   1. Lighting Controls

C. Refer to Division 01 Section "General Commissioning Requirements" for general commissioning scope.

1.4 DEFINITIONS

A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 DOCUMENTATION

A. Refer to Division 01 Section "General Commissioning Requirements" for documentation to be provided by the CxA.

A. Refer to Division 01 Section "General Commissioning Requirements" for documentation to be provided by the construction manager and contractor. In addition, provide the following:

   1. Equipment Start Up Reports. See equipment specific specifications for Start Up requirements.

1.6 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.
PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from the vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Temporary data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

PART 3 EXECUTION

3.1 STARTUP PLANS AND REPORTS

A. For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 2 weeks prior to startup.

B. For each item of equipment and system for which the manufacturer provides a startup report, document compliance by submitting the completed startup checklist and final startup report, signed and dated by the responsible entity.

3.2 PREFUNCTIONAL CHECKLISTS

A. A Prefunctional Checklist is required to be filled out for each item of equipment or system to be commissioned.

1. These checklists do not replace manufacturer’s recommended startup checklists regardless of apparent redundancy.

2. The following types of information will be gathered via the completed Prefunctional Checklist forms:
   a. Certification by installing contractor that the unit is properly installed, started up, operating, and ready for Functional Testing.
   b. Manufacturer, model number, and relevant capacity information. List information "as installed."
   c. Serial number of installed unit.

B. Contractor is responsible for filling out Prefunctional Checklists after completion of installation and before operational startup. Witness of operational startup by the Commissioning Authority is not required unless otherwise specified.

1. Each line item is to be initialed and dated by the Contractor. Checklists are not complete until all line items are initialed and dated without deficiencies.

2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing. Re-submission of the Checklist is required upon completion of remaining items.
3. Individual Checklists may contain line items that are the responsibility of more than one installer. Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
4. If any Checklist line item is not relevant, record reasons on the form.
5. Contractor may independently perform startup inspections and/or tests at Contractor's option.
6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
7. Submit completed Checklists to Commissioning Authority within two days of completion.

C. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.

1. Provide all additional information requested by Commissioning Authority to aid in preparation of Checklists, such as shop drawing submittals, manufacturer’s startup checklists, and operation & maintenance data.
2. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in Contract Documents or not.

D. Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.3 FUNCTIONAL TESTS

A. A Functional Test is required for EACH item of equipment, system, or other assembly specified to be commissioned unless SAMPLING of multiple identical units is allowed by the final test procedures.
B. Contractor is responsible for execution of required Functional Tests after completion of Prefunctional Checklists and before closeout.
C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation of forms for that purpose.
D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner. If a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and record the Contractor’s stated intentions for correction.

1. Deficiencies are any condition in the installation or function of a component, piece of equipment, or system that is not in compliance with Contract Documents or does not perform properly.
2. When the deficiency has been corrected, the Commissioning Authority will reschedule the test and the Contractor shall re-test.
3. If 10 percent of identical items fail to perform due to materials or manufacturing defect, all items will be considered defective. Contractor shall provide a proposal for correction within 2 weeks after notification of defect.
4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time to witness re-testing.

E. Functional Test Procedures:

1. Examples of Functional Testing:
   a. Test the dynamic function of equipment and systems using direct observation and/or monitoring methods under full operation.
b. Systems are tested under various conditions such as high heating/cooling loads, low heating/cooling loads, component failures, unoccupied mode, fire alarm, power failure, etc.

c. Systems are subjected to all controls and building automation system sequences of operation. Components are verified to respond accordingly.

F. Deferred Functional Tests: Some tests may need to be performed after substantial completion due to partial occupancy, seasonal requirements, or other site conditions. Performance of these tests remains the Contractor's responsibility regardless of timing.

3.4 TEST PROCEDURES – GENERAL

A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

B. Provide all necessary materials and system modifications required to produce flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test conditions.

C. Identical Units

1. Identical units are defined as those with the same application and sequence of operation except for minor size or capacity differences.

2. Where sample Functional Testing of identical units is permitted, test 30% of the project total. If half of these units fail Functional Testing, all units (i.e. 100% of the project total) shall be inspected and issues remediated by the Contractor. Thereafter, all units (i.e. 100% of the project total) shall undergo Functional Testing.

3. Sampling is not allowed for:
   a. Major equipment.
   b. Life-safety-critical equipment.

D. For Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance.

E. For Simulated Conditions: Artificially create the necessary condition for the purpose of testing the response of a system.

F. For Over-Writing Values: Change the sensor value known to the control system to see the response of the system.

G. For Indirect Indicators: Observe a response or condition indirectly from a control system screen or other device.

H. For Monitoring: Record parameters of equipment operation using trending capabilities of the control system. Where monitoring of specific points is called for in Functional Testing, complete the following:

   1. Provide hard copies of monitored data in columnar format.
   2. Alternately, provide graphical output if producible by the system.

3.5 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 7700 - Closeout Procedures for additional requirements.

B. Contractor provides final operation & maintenance manuals of commissioned equipment to the Commissioning Authority for review. Contractor makes changes recommended by the Commissioning Authority.
3.6 DEMONSTRATION AND TRAINING

A. Contractor submit training plan for Owner personnel to the Commissioning Authority for review and approval.
B. Contractor coordinate scheduling of specified training sessions with invitations to the Commissioning Authority.
C. Contractor provide sign-in sheet and agenda for each training session along with copies of training aids and documentation to the Commissioning Authority for review.

END OF SECTION 26 0800
SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following lighting control devices:
      1. Time switches.
      2. Outdoor and indoor photoelectric switches.
      3. Indoor occupancy sensors.
      4. Lighting contactors.
      5. Emergency shunt relays.
   B. Related Sections include the following:
      1. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
      2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.
      3. Division 26 Section "Theatrical Lighting" for theatrical lighting controls.

1.3 DEFINITIONS
   A. LED: Light-emitting diode.
   B. PIR: Passive infrared.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For all occupancy sensors and light level sensors:
      1. Include plans detailing manufacturer recommended occupancy sensor types, locations, and aiming. The manufacturer shall consider room configurations, furniture configurations, and other room conditions to optimize for full room coverage.
      2. Interconnection diagrams showing field-installed wiring.
   C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Occupancy sensors shall be tested to meet the NEMA WD7.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Intermatic ET70415CR or a comparable product by one of the following:

2. Paragon Electric Co.; Invensys Climate Controls.
3. Square D; Schneider Electric.
4. TORK.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPDT.
3. Programs: 4 channels; each channel shall be individually programmable with a minimum of 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays. Program data shall be stored with non-volatile memory for the life of the time switch without the need for battery back-up.
4. Astronomic Time: All channels.
5. Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Intermatic, Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Cooper Controls, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK.
8. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
   2. Time Delay: 10-second minimum, to prevent false operation.
   4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Eaton Electrical Inc; Cutler-Hammer Products.
   4. Intermatic, Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Cooper Controls, Inc.
   9. Square D; Schneider Electric.
   10. TORK.
   11. Watt Stopper (The).

B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
   1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
   4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with dead band adjustment.
   5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit, to detect
changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

INDOOR OCCUPANCY SENSORS

A. Wall mounted occupancy sensor single switch type.

B. Wall or ceiling mounted dual, (passive infrared with ultrasonic or microphonic) or single technology as indicated below.

C. Infrared Wall-Switch Sensors (Type “OCA”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide The Watt Stopper WS-200 or comparable product by one of the following:
   b. Cooper Controls
   c. Sensor Switch, Inc.
   d. Philips-Lightolier Controls

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

D. Dual-Technology Ceiling or Wall Mounted Sensors (Type “OCB”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide The Watt Stopper DT-200 or comparable product by one of the following:
   b. Cooper Controls, Inc.
   c. Sensor Switch, Inc.
   d. Philips-Lightolier Controls

2. Description: Combination passive-infrared and ultrasonic type, adjustable time delay up to 30 minutes, adjustable sensitivity, 90-degree field of view, with single-pole, double-throw isolated relay, and with a minimum coverage area of 2000 sq. ft. Provide power packs or accessories as necessary to control 120V or 277V rated loads. Provide an additional single-pole, double-throw isolated relay for HVAC control system interface.

E. Dual-Technology Ceiling or Wall Mounted Sensors (Type “OCC”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide The Watt Stopper DT-300 or comparable product by one of the following:
   b. Cooper Controls, Inc.
   c. Sensor Switch, Inc.
   d. Philips-Lightolier Controls
2. **Description:** Combination passive-infrared and ultrasonic type, adjustable time delay up to 30 minutes, adjustable ultrasonic sensitivity, 360-degree field of view, with an integral single-pole, double-throw isolated relay, and with a minimum coverage area of 1000 sq. ft. Provide power packs or accessories as necessary to control 120V or 277V rated loads. Provide an additional single-pole, double-throw isolated relay for HVAC control system interface.

### 2.5 LIGHTING CONTACTORS

**A. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. GE Industrial Systems; Total Lighting Control.
5. Hubbell Lighting.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Square D; Schneider Electric.
8. Watt Stopper (The).

**B. Description:** Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.

1. **Current Rating for Switching:** Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. **Fault Current Withstand Rating:** Equal to or exceeding the available fault current at the point of installation.
3. **Enclosure:** Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

### 2.6 EMERGENCY SHUNT RELAY

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

1. The Bodine Company, Inc.
2. Lighting Control and Design, Inc.
3. LVS, Inc.

**B. Description:** Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. **Coil Rating:** 120 or 277V as required.
2. Emergency lighting test function shall be provided to maintain the selected light fixtures energized for 5 seconds after the manual or automatic light switch disconnects the light fixtures on the same switch leg.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR BASIS-OF-DESIGN

A. The Drawings show a Wattstopper basis-of-design and only indicate potentially suitable occupancy sensor types and locations. The manufacturer shall examine the plan spaces and provide the most suitable occupancy sensor(s) for each space based on room and furniture configurations and other room conditions. Occupancy sensor location plan drawings shall be required as submittals for approval by the Architect/Engineer. The Contractor's Bid shall include all extra wiring and components for a fully functional occupancy control system; extra components may include power packs, slave packs, form C packs, relays, switch packs, and mounting brackets.

3.2 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions. Adjust sensor sensitivities and timers to optimize performance.

B. Occupancy sensors shall be located to:
   1. Be able to detect minor movement,
   2. Not operate nuisance switching due to ambient airflow or passerby traffic.
   3. Minimize damage from room function. Provide a protective wire cage on sensors installed in gymnasiums and locker rooms.

3.3 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 26 0923
SECTION 26 0943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes manually operated lighting controls with relays and control module.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.
   2. Division 26 Section "Central Dimming Controls" or "Modular Dimming Controls" for dimming control components.

C. Sequence of Operation
   1. Refer to the drawings for project specific scenes and control functions.
   2. Upon a signal from the fire alarm system all light fixtures shall come up to full brightness.
   3. Where power supplied to emergency egress light fixtures is from an alternate external source such as an inverter or an engine generator, upon loss of normal power the light fixtures shall come up to full brightness.

1.3 DEFINITIONS
A. BACnet: A networking communication protocol that complies with ASHRAE 135.
B. BAS: Building automation system.
C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
F. PC: Personal computer; sometimes plural as "PCs."
G. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.
1.4 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
   1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

E. Field quality-control test reports.

F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS system. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of software input/output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Damage of electronic components due to transient voltage surges.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Lighting control system basis of design is by Crestron Electronics. Subject to compliance with requirements, other manufacturers eligible for approval are:
   1. Intelligent Lighting Controls, Inc.
   2. Lighting Control & Design, Inc.
   3. Watt Stopper (The).
   4. Philips-Lightolier Controls
   5. Acuity nLight
2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
   1. Acceptable communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.3 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.
   1. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
   2. Interoperability: Control module shall be configured to connect to BACnet-compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
   3. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.
   4. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
   5. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
   6. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
   7. Astronomic Control: Automatic adjustment of dawn and dusk switching.
   8. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device.
      a. Lamp or LED at control module or display panel shall identify status of each controlled circuit.
9. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.

10. Telephone Override Capability: Override programmed lighting shutdown commands by telephoning computer and shall enter a voice-menu-guided, override touch-tone code specific to zone being controlled.

11. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.

12. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Comply with provisions in the latest ASHRAE Standard 90.1

13. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.

14. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.

15. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

16. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.

17. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

18. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

19. Additional Programming: In addition to system programming by the PC, individual control modules shall be programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

2.4 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.
   a. Barriers separate low-voltage and line-voltage components.
   b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
c. Endurance: 50,000 cycles at rated capacity.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Division 26 Section “Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits” for Category A locations.

2.5 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.

1. Match color specified in Division 26 Section "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."

C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."

D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 24 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings and gypsum board partitions. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" Minimum conduit size shall be 1/2 inch.
   1. Where raceways are not used, wiring shall be installed in a neat and workmanlike manner and installed parallel with or at right angles. Bridal rings, straps, hangers or similar fittings designed for supporting cables shall be used (spaced per manufactures recommendations).

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.
3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner’s personnel in making program changes 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 lighting controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 0943
SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS
A. Operation and Maintenance Data: For transformers to include in emergency, operation and maintenance methods.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers

1.5 DELIVERY, STORAGE, AND HANDLING
A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION
A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; Schneider Electric (basis of design).
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
5. Siemens Energy & Automation, Inc.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Indoor Enclosures: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Outdoor Enclosures: Ventilated or totally enclosed, nonventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 gray.

F. Taps for Transformers Smaller Than 3 kVA: None.

G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
H. Taps for Transformers: 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capacity to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

L. Wall Brackets: Manufacturer’s standard brackets.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 37 dBA.
2. 30 to 50 kVA: 42 dBA value.
3. 51 to 150 kVA: 47 dBA value.
4. 151 to 300 kVA: 52 dBA value.
5. 301 to 500 kVA: 57 dBA value.
6. 501 to 750 kVA: 59 dBA value.
7. 751 to 1000 kVA: 61 dBA value.

2.4 VIBRATION MOUNTINGS

A. Description: Vibration isolators and mounting rails to isolate transformer from structure, reducing transmitted noise.

B. Vibration Isolators for Floor and Wall Mounted Transformers: Provide steel housed open spring isolators seated in rubber with provisions for leveling and bolting to mounting rails and concrete base or wall brackets.

C. Mounting Rails: Provide steel channels. To insure adequate stiffness, height of channel shall be a minimum of 8 percent of longest channel dimension.

D. Vibration Isolators for Suspended Transformers: Provide steel spring and rubber isolation hangers with provisions for bolting to trapeze hangers.

E. Vibration isolator manufacturer shall select units suitable for transformers indicated. Vibration isolator manufacturer shall determine quantity of units, but not less than four per transformer.
2.5 IDENTIFICATION DEVICES
   A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL
   A. Test and inspect transformers according to IEEE C57.12.91.
   B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
   B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
   C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
   D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
   E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".
   C. Install distribution transformers 15 kVA and larger on vibration mountings.

3.3 CONNECTIONS
   A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Make connections to transformers using flexible metallic conduit of adequate length to absorb vibration and movement.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.


3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 2200
SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Service and distribution switchboards rated 600 V and less.
      2. Transient voltage suppression devices.
      3. Disconnecting and overcurrent protective devices.
      4. Instrumentation.
      5. Control power.
      6. Accessory components and features.
      7. Identification.

1.3 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEVASCE 7
   B. 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.4 SUBMITTALS
   A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   B. Shop Drawings: For each switchboard and related equipment.
      1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
      2. Detail enclosure types for types other than NEMA 250, Type 1.
      3. Detail bus configuration, current, and voltage ratings.
      5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
      6. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
7. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified Installer.

D. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Variation and Seismic Controls for Electrical Systems". Include the following:

E. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. 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.

G. Operation and Maintenance Data: For switchboards and components 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. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
F. Comply with NEMA PB 2.
G. Comply with NFPA 70.
H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.
C. Service Conditions: NEMA PB 2, usual service conditions as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.
D. 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 five days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager’s written permission.
   4. Comply with NFPA 70E.
1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric (basis of design).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. ABB / GE.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: As denoted on Drawings.

D. Main-Bus Continuous: As denoted on Drawings.
E. **Seismic Requirements:** Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".

F. **Indoor Enclosures:** Steel, NEMA 250, Type 1.

G. **Enclosure Finish for Indoor Units:** Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface. (Interior and exterior).

H. **Utility Metering Compartment:** Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

I. **Customer Metering Compartment:** A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

J. **Bus Transition and Incoming Pull Sections:** Matched and aligned with basic switchboard.

K. **Removable, Hinged Rear Doors and Compartment Covers:** Secured by standard bolts, for access to rear interior of switchboard.

L. **Hinged Front Panels:** Allow access to circuit breaker, metering, accessory, and blank compartments.

M. **Pull Box on Top of Switchboard:**
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating; fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

N. **Buses and Connections:** Three phase, four wire unless otherwise indicated.
   1. **Phase- and Neutral-Bus Material:** Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. **Load Terminals:** Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. **Ground Bus:** 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

O. Each switchboard assembly employed as service entrance equipment shall have a removable main bond bus link between the neutral and equipment ground bus work. It shall also include a barrier to separate incoming service conductors from feeder conductors.

P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. ABB / GE.
   4. Square D, a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition updated version, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120-V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240-V or 480-V, three-phase, three-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V and 1000 V for 240 V.
2. Line to Ground: 1500 V for 480 V and 800 V for 240 V.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller, let-through ratings less than NEMA FU1, RK-5.
5. GFCI Circuit Breakers: Single-and two-pole configurations with Class A ground-fault protection. (6-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integ­rally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

e. Zone-Selective Interlocking: Integral with electronic trip unit for interlocking ground-fault protection function.

f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section “Electrical Power Monitoring and Control.”

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.

h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

i. Auxiliary Contacts: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contract, “b” contacts operate in reverse of circuit-breaker contacts.

j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation, key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time time adjustments.
   c. Ground-fault pickup level, time delay, and I¹t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

5. Remote trip indication and control.

6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section “Electrical Power Monitoring and Control.”

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Control Voltage: [40-V dc] [125-V dc] [250-V dc] [120-V ac].

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Boltswitch, Inc.
   b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   c. Pringle Electrical Manufacturing Company, Inc.
   d. Siemens Energy & Automation, Inc.
   e. Square D; a brand of Schneider Electric.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

5. Service-Rated Switches: Labeled for use as service equipment.

6. Ground-Fault Relay: Comply with UL 1053, self-powered type with mechanical ground fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
   Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   a. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
   b. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
   c. Test Control: Simulates ground fault to test relay and switch (or relay only if “no-trip” mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.

D. Fused Switch: NEMA KS1, Type HD, clips to accommodate specified fuses, lockable handle.

E. Fuses are specified in Division 26 Section “Fuses”.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following
   Potential Transformers: IEEE C57.13; 120 V, 60 Hz; disconnecting type with integral fuse mountings.
   Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.


B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Megawatts: Plus or minus 2 percent.
      e. Megavars: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
      i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
      j. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.


D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies". Drawings indicate general arrangement of bus fittings and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems". Drawings indicate general arrangement of cable trays, fittings and specialties.
3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.
3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 2413
SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Electronic-grade panelboards.

1.3 DEFINITIONS
A. SVR: Suppressed voltage rating.
B. TVSS: Transient voltage surge suppressor.
C. SPD: Surge protective device.

1.4 SUBMITTALS
A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.
   7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section “Vibration and Seismic Controls for Electrical Systems”. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Operation and Maintenance Data: For panelboards and components 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 overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated.

1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager’s written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section “Vibration and Seismic Controls for Electrical Systems”.

PANELBOARDS 26 2416 - 3
B. Enclosures: Flush- and surface-mounted cabinets. Comply with UL 67

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
   d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.


C. Phase, Neutral, and Ground Buses:

2. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: Labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric (basis of design).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. ABB / GE.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Mains: Refer to Drawings for Circuit breaker, Fused switch, or Lugs only.


E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

G. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric (basis of design).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Refer to Drawings for Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller, with same short-circuit interrupting rating as panelboard.
1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Provide each panel with a door in a door cover. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 ELECTRONIC-GRADE PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D, a brand of Schneider Electric (basis of design).
2. Current Technology, a subsidiary of Danaher Corporation.
5. Liebert Corporation.

B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses. 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, third edition updated version, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

1. Accessories:

   a. Fabrication using bolted compression lugs for internal wiring.
   b. Redundant suppression circuits.
   c. Redundant replaceable modules.
   d. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   e. LED indicator lights for power and protection status.
   f. Audible alarm, with silencing switch, to indicate when protection has failed.
   g. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   h. Four-digit, transient-event counter set to totalize transient surges.
   a. Line to Neutral: 70,000 A.
   b. Line to Ground: 70,000 A.
   c. Neutral to Ground: 50,000 A.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120-V, three-phase, four-wire circuits shall be as follows:
   a. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
   b. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
   c. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
5. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
   a. Line to Neutral: 400 V.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.
6. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
   a. Line to Neutral: 400 V, 800 V from high leg.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.
7. Protection modes and UL 1449 SVR for 240-V or 480-V, three-phase, three-wire, delta circuits shall be as follows:
   a. Line to Line: 2000 V for 480 V and 1000 V for 240 V.
   b. Line to Ground: 1500 V for 480 V and 800 V for 240 V.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric (basis of design).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.


3. Electronic trip circuit breakers with rms-sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses, lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section “Fuses”.

2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install floor-mounted distribution panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete".

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section “Vibration and Seismic Controls for Electrical Systems”.

E. Mount top of trim 90 inches above finished floor unless otherwise indicated. If necessary, lower mounting height to insure the operating handle of the top-most switch or circuit breaker, in on position, is not higher than 79 inches (2000 mm) above finished floor.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Where panelboards are located in finished spaces, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Where panelboards are located above raised floor space, stub four 1-inch empty conduits into raised floor space.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.
3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

   1. For existing panelboards, replace existing directories with new to indicate new and existing circuits.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:

   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section “Overcurrent Protective Device Coordinate Study.”

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

   1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer’s written instructions.

END OF SECTION 26 2416
SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Isolated-ground receptacles.
4. Snap switches and wall-box dimmers.
5. Pendant cord-connector devices.
6. Cord and plug sets.
7. Floor service outlets
8. Poke-through assemblies
9. Service poles
10. Multioutlet assemblies.

B. Related Sections include the following:

1. Division 27 Section “Communications Horizontal Cabling” for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Samples: One for each type of device and wall plate specified, in each color specified.
C. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Arrow Hart Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Legrand Pass & Seymour.

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Arrow Hart Cooper; 5351 (single), 5352 (duplex).
   b. Hubbell; HBL5351 (single), HBL5352 (duplex).
   c. Leviton; 5351 (single), 5352 (duplex).
   d. Legrand Pass & Seymour; 5361 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
Products: Subject to compliance with requirements, provide one of the following:

a. Arrow Hart Cooper; IG5362.
b. Hubbell; CR 5252IG.
c. Leviton; 5362-IG.
d. Legrand Pass & Seymour; IG5362.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

Products: Subject to compliance with requirements, provide one of the following:

a. Arrow Hart Cooper; TR8300.
b. Hubbell; HBL8300SG.
c. Leviton; 8300-SGG.
d. Legrand Pass & Seymour; TR63H.

2. Description: Labeled to comply with NFPA 70.

D. USB Combination Receptacle: Provide duplex receptacle as specified above, along with two integral USB charging ports. Each USB port shall be rated 2.1A minimum at 5VDC, and shall be compatible with USB 2.0 & 3.0 devices.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Arrow Hart Cooper TR7746
b. Legrand Pass & Seymour TR5362USB
c. Leviton T5632-W

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

, Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Arrow Hart Cooper; GF20.
b. Legrand Pass & Seymour; 2095.

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Crouse-Hinds.
   b. EGS/Appleton Electric.
   c. Killark; a division of Hubbell, Inc.
   d. Legrand Pass & Seymour

2.5 TWIST LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; CWL520R.
   b. Hubbell; HBL2310.
   c. Leviton; 2310.
   d. Legrand Pass & Seymour; L520-R

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; IGL520R
   b. Hubbell; IG2310.
   c. Leviton; 2310-IG.
   d. Legrand Pass & Seymour; IGL520-R

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R (or as indicated on Drawings), heavy-duty grade.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; CWL520P, CWL520C with I-Grip Strain Relief

2. Description
   b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.
2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; AH1221 (single pole), AH1222 (two pole), AH1223 (three way), AH1224 (four way).
   b. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).
2. Description: Industrial extra heavy-duty specification grade switches.

C. Illuminated Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; AH1221LT for 120/277V.
   b. Hubbell; HBL1221IL for 120/277V.
   c. Leviton; 1221-LH for 120V, 1221-7L for 277V.
   d. Pass & Seymour; PS20AC1 for 120/277V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is “OFF”. Refer to “FINISHES” herein for color.

D. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Arrow Hart Cooper; AH1221PL for 120 V and 277 V.
   b. Hubbell; HPL 1221PL for 120 V and 277 V.
   c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
   d. Pass & Seymour; PS20AC1-RPL for 120 V, PS20AC1-RPL7 for 277 V.
2. Description: Single pole, with red neon-lighted handle, illuminated when switch is “ON”.

WIRING DEVICES
E. Key-Operated Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Arrow Hart Cooper; AH1221L.
      b. Hubbell; HBL1221L.
      c. Leviton; 1221-2L.
      d. Pass & Seymour; PS20AC1-L.
   2. Description: Single pole, with factory-supplied key in lieu of switch handle.

F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Hubbell; HBL1557.
      c. Leviton; 1257.
      d. Pass & Seymour; 1251.

G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Arrow Hart Cooper; 1995L.
      b. Hubbell; HBL1557L.
      c. Leviton; 1257L.
      d. Pass & Seymour; 1251L.

2.9 WALL-BOX DIMMERS
   A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
   B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

2.10 WALL PLATES
   A. Single and combination types to match corresponding wiring devices.
      1. Plate-Securing Screws: Metal with head color to match plate finish.
      2. Material for Finished Spaces: 0.035-inch- thick, satin-finished type 302 stainless steel.
3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.11 FLOOR SERVICE FITTINGS

A. Type: Modular, flush flap-type, dual-service units suitable for wiring method used, except in kitchens use modular, above-floor, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular with satin finish (unless noted otherwise).

D. Carpet Flange: Rectangular with satin finish (unless noted otherwise).

E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

F. Voice and Data Communication Outlet: Standard, single-gang device opening capable of accepting 1-6 per duplex frame (by others). Provide finishing plate.

2.12 MULTIOUTLET ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.

2.13 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communications cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports, with pole foot and carpet pad attachment.
3. Finishes: Selected by the Architect/Engineer from manufacturer’s standard painted finish and trim combinations.
4. Wiring: Sized for minimum of five No.12 AWG power and ground conductors and a minimum of four, 4-pair, Category 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.

2.14 FINISHES
A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
   3. Isolated-Ground Receptacles: White with orange triangle designation on face.
   4. Wiring Devices Connected to Technology Grade Panelboards: White unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtales.
   4. Quick snap connecting devices are not acceptable.
Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtailst that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtaill for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.


I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Provide Tamper-Resistant type receptacles in all facilities frequented by children as described by NFPA 70, including:

1. Child Care Facilities, Preschools, Elementary Education Facilities,
2. Dwelling Units,
3. Business Offices, Corridors, Waiting Rooms and the like in Clinics, Medical and Dental Offices and Outpatient Facilities;
4. Assembly Occupancies (Transportation Waiting, Gymnasiums, Skating Rinks, Auditoriums;
5. Dormitories
3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles and switches: Identify panelboard and circuit number from which served. Use durable wire marker on the back (inside) of the cover plate.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value above five percent is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 2726
SECTION 26 2813 - FUSES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches and panelboards, switchboards and enclosed controllers, and motor-control centers.
      2. Spare-fuse cabinets.

1.3 SUBMITTALS
   A. 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.

1.4 QUALITY ASSURANCE
   A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   C. Comply with NEMA FU 1 for cartridge fuses
   D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS
   A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer’s ambient temperature adjustment factor to fuse ratings.
1.6 COORDINATION
   A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussmann, Inc.
      2. Ferraz Shawmut, Inc.
      3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
   B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
   C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
   D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
   E. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay.
2. Feeders: Class L, time delay for feeders over 600 amps, Class RK1, time delay for smaller feeders.
3. Motor Branch Circuits: Class RK1, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) where indicated by the Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813
SECTION 26 2816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Enclosures.

1.3 SUBMITTALS

A. 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.

B. Operation and Maintenance Data: For enclosed switches 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 switches.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.
1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.
   4. Comply with NFPA 70E.

1.6 COORDINATION

A. Coordinate layout and installation of switches and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric (basis of design).
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Type HD, Heavy Duty, Single Throw, 240-V or 600-V ac as required, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. UL 98 Enclosed and Dead-Front Switches

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   6. Hazardous Areas Indicated on Drawings: NEMA 250, \textbf{[Type 7] [Type 9]}.
   7. 
   8. NEMA 7 is for Class I, Division I, Groups A,B,C, or D, NEMA 9 enclosures are designed to prevent the ignition of combustible dust

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
      1. Across-the-line, manual and magnetic controllers.
      2. Multispeed controllers.

1.3 SUBMITTALS
   A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's
      technical data on features, performance, electrical characteristics, ratings, and finishes.
   B. Shop Drawings: For each enclosed controller.
      1. Include dimensioned plans, elevations, sections, and details, including required
         clearances and service space around equipment. Show tabulations of installed devices,
         equipment features, and ratings. Include the following:
            a. Each installed unit's type and details.
            b. Nameplate legends.
            c. Short-circuit current rating of integrated unit.
            d. Listed and labeled for series rating of overcurrent protective devices in
               combination controllers by an NRTL acceptable to authorities having jurisdiction.
            e. Features, characteristics, ratings, and factory settings of individual overcurrent
               protective devices in combination controllers.
      2. Wiring Diagrams: Power, signal, and control wiring.
   C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required
         working clearances, and required area above and around enclosed controllers where pipe and
         ducts are prohibited. Show enclosed controller layout and relationships between electrical
         components and adjacent structural and mechanical elements. Show support locations, type of
         support, and weight on each support. Indicate field measurements.
   D. Field quality-control test reports.
   E. Operation and Maintenance Data: For enclosed controllers 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. Routine maintenance requirements for enclosed controllers and all installed components.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

   1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electrical service.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every ten installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D (basis of design).
2. ABB / GE.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. The external operating mechanism shall be provided, from the factory, with the capability of locking the electrical contacts in the open position. The locking mechanism shall be key operated.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Minimum controller size shall be NEMA size 1.
C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 MULTISPEED ENCLOSED CONTROLLERS
A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
   1. Compelling relay to ensure that motor will start only at low speed.
   2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
   3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES
A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES
A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
D. Control Relays: Auxiliary and adjustable time-delay relays.
E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.6 FACTORY FINISHES
A. Finish: Manufacturer's standard gray paint applied to factory-assembled and -tested enclosed controllers before shipping.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
      1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS
   A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
   B. Select horsepower rating of controllers to suit motor controlled.
   C. Furnish and install phase-failure and undervoltage relays for all combination magnetic controllers controlling motors five horsepower or larger.

3.3 INSTALLATION
   A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
   B. Install freestanding equipment on concrete bases.
   C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
   D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES
   A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
   B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION
   A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."
3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
      a. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
      b. Test continuity of each circuit.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 2913

ENCLOSED CONTROLLERS 26 2913 - 6
SECTION 26 5100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, ballasts and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors UL 924 relays, and multipole lighting relays and contactors.
2. Division 26 Specification section for dimming controls.
3. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-Voltage control wiring or data communication circuits.
4. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

1.3 DEFINITIONS

A. BF: Ballast factor.
B. CRI: Color-rendering index.
C. CU: Coefficient of utilization.
D. HID: High-intensity discharge.
E. LED: Light Emitting Diode
F. LER: Luminaire efficacy rating.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.
H. RCR: Room cavity ratio.
1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Photometry data for luminaire to include:
   a. Candlepower distribution diagram and chart
   b. Zonal lumen summary chart & luminaire efficiency percentage
   c. Delivered lumen data for LED luminaires
   d. Total luminaire wattage
3. Emergency lighting units including battery and charger.
4. Ballast or driver, including BF.
5. Energy-efficiency data.
6. Life, output, and energy-efficiency data for lamps or light sources.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.


C. Field quality-control test reports.

D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturer’s codes. Include manufacturer’s name, wattage, CRI, life & color temperature.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1. Create Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
a. Lighting fixtures.
b. Suspended ceiling components.
c. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
d. Ceiling-mounted projectors.
e. Structural members to which suspension systems for lighting fixtures will be attached.
f. Access panels.
g. Other items in finished ceiling including, but not limited to the following:
   1) Air outlets and inlets.
   2) Speakers.
   3) Sprinklers.
   4) Smoke and fire detectors.
   5) Occupancy sensors.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: Ten years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
   2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: One year(s) from date of Substantial Completion.

D. Special Warranty for LED Sources and Drivers: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace LED sources or drivers that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Five year(s) from date of Substantial Completion.
1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts/Drivers: 1 for every 100 of each type and rating installed. Furnish a minimum of one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Fluorescent, HID, Incandescent, and LED Fixtures: Comply with UL 1598.
C. Metal Parts: Free of burrs and sharp corners and edges.
D. Sheet Metal Components:
   1. Steel, minimum 22 gauge for troffers, unless otherwise indicated.
   2. Form and support to prevent warping and sagging.
E. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools.
   2. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
   3. Spring loaded cam latches.
   4. Designed and fabricated to include reinforcing to prevent warping.
F. All metal parts shall be painted after fabrication.
G. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.

b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

H. Provide integral accessible disconnecting means for fluorescent luminaires that utilize double-ended lamps and contain ballast(s) that can be serviced in place or ballasted luminaires that are supplied from multi-wire branch circuits and contain ballast(s) that can be serviced in place.

I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, ballasts, and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Labels shall include the following lamp and ballast characteristics:

   a. “USE ONLY” and include specific lamp type.
   b. Lamp diameter code (i.e. T-4, T-5, T-8), tube configuration (i.e. twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaries.
   c. Lamp type, wattage, bulb type (i.e. ED17, BD56) and coating (clear or coated) for HID luminaries.
   d. Start type (i.e. programmed rapid start) for fluorescent and compact fluorescent luminaries.
   e. ANSI ballast type (i.e. M98, M57) for HID luminaires.
   f. CCT and CRI for all luminaires.

2.3 LED SOURCES


B. LED sources shall have a color temperature of 3500K and a minimum CRI of 80, with an R9 value of >50.

C. LED sources shall start and operate in 0°F to 40°F ambient.

D. LED sources shall be designed for ease of component replacement and end-of-life disassembly from room side. All internal components shall be assembled and pre-wired using modular electrical connections.

E. LED sources shall be RoHS compliant (Restriction of Hazardous Substances).

F. LED sources shall be binned to a 3 step MacAdam ellipse (SDCM: Standard Deviation Color Matching) of the 3500K Planckian Locus to ensure color consistency.

G. LED products must have a minimum 5 year warranty for replacement of all components, including LED board or driver.
2.4 DRIVERS FOR DIMMER CONTROLLED LED FIXTURES

A. 10% Dimmable Driver for LED Fixtures – Description: Electronic driver shall be designed for type and quantity of LED fixtures served and for full light output. Comply with NEMA SSL 1, UL 8750, ANSI C62.41, Category A and the following:

1. Dimming Range: 100% to 10% of rated lumens with continuous, flicker-free 0-10V dimming.
2. Operating Voltage: 120-277V at 50/60Hz.
3. Rated Lifetime: 50,000 hours at drive case temperature of 149 deg F.
4. Sound Rating: Class A.
5. Starting Temperature: Shall start the lamp(s) at 32°F or higher.
6. Total Harmonic Distortion Rating: Less than 20 percent.
7. Standby Power Consumption: Less than 1.0 watt.
8. Power Factor: 0.90 or higher.
10. Transient Voltage Protection: Follow ANSI C62.41 to provide Category A rating or better.
12. LEDs turn on to any dimmed level without going to full brightness.
13. Nonvolatile memory restores all driver settings after power failure.
14. Turn-on time: Less than 1 second.
15. RFI Requirements: Labeled for radio frequency interference (RFI) requirements of FCC Title 47 Part 15.

B. 3-Wire Control, 1% Dimmable Driver for LED Fixtures – Description: Electronic driver shall be designed for type and quantity of LED fixtures served and for full light output. Comply with UL 8750, ANSI C62.41, Category A and the following:

1. Products:
   a. Lutron Hi-Lume A-Series L3D.
2. Dimming Range: 100% to 1% of rated lumens with continuous, flicker-free dimming.
3. Operating Voltage: 120-277V at 50/60Hz.
4. Output Power: 5 to 40 watts.
5. Rated Lifetime: 50,000 hours at drive case temperature of 149 deg F.
6. Sound Rating: Class A.
7. Starting Temperature: Shall start the lamp(s) at 32°F or higher.
8. Total Harmonic Distortion Rating: Less than 20 percent at 40 watts.
9. Standby Power Consumption: Less than 1.0 watt.
10. Power Factor: 0.90 or higher at 40 watts.
12. Transient Voltage Protection: Follow ANSI C62.41 to provide Category A rating or better.
14. LEDs turn on to any dimmed level without going to full brightness.
15. Nonvolatile memory restores all driver settings after power failure.
16. Turn-on time: Less than 1 second.
18. Driver Output: Provide constant current driver with pulse width modulation (PWM) dimming, constant current driver with constant current reduction (CCR) dimming, or
constant voltage driver with pulse width modulation (PWM) dimming as required by the LED fixture manufacturer.

2.5

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit Voltage drops to 80 percent of nominal Voltage or below. When normal Voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   f. Universal mounting unless a specific mounting is indicated.
   g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by a flashing red LED.

2.6 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit Voltage drops to 80 percent of nominal Voltage or below. Lamp automatically disconnects from battery when Voltage approaches deep-discharge level. When normal Voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. LED light source.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
7. Wire Guard: Where indicated on Drawings, provide heavy-chrome-plated wire guard protects lamp heads or fixtures.
8. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciacted by a flashing red LED.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel.

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line Voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Fixtures with Same Dimensions As Ceiling Grid:
   a. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
   b. 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.

2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independent of acoustical panel with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

C. 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.

D. Adjust aimable lighting fixtures to provide required light intensities. Coordinate aiming requirements with [Owner] [Architect].

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Clean lamps, lenses, and reflectors of all dirt, debris, paint, and fingerprints prior to Substantial Completion of Work.

G. Lamps, ballasts and drivers shall be in working order at the time of Substantial Completion of Work.

H. Remote Mounting of drivers and Ballasts: Distance between the driver/ballast and the fixture shall not exceed that recommended by ballast manufacturer. Verify with manufacturers for maximum distances.

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt normal power supply to demonstrate proper operation. Verify transfer from normal power to emergency source (battery, generator, etc) and retransfer to normal.

3.3 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide one visit to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

END OF SECTION 26 5100
SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Exterior luminaires with lamps and ballasts.
   B. Related Sections include the following:
      1. Division 26 Section “Interior Lighting” for exterior luminaires normally mounted on exterior surfaces of buildings.
      2. S265619 LED EXTERIOR LIGHTING: for pole mounted and bollard fixtures.

1.3 DEFINITIONS
   A. CRI: Color-rendering index.
   B. HID: High-intensity discharge.
   C. LED: Light Emitting Diode type lamp/light source.
   D. Luminaire: Complete lighting fixture, including ballast housing if provided.
   E. Pole: Luminaire support structure, including tower used for large area illumination.
   F. Standard: Same definition as “Pole” above.

1.4 SUBMITTALS
   A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
      1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
      2. Details of attaching luminaires and accessories.
      3. Details of installation and construction.
      4. Luminaire materials.
      5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products and include:
   1) Candlepower distribution diagram and chart
   2) Zonal lumen summary chart & luminaire efficiency percentage
   3) Delivered lumen data for LED luminaires
   4) Total luminaire wattage

6. Ballasts, including energy-efficiency data.
7. Lamps, including life, output, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

B. Shop Drawings:
   1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

D. Warranty: Provide certificate of warranty which complies with the special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IESNA standards, guidelines and recommended practices for the provided luminaires.

D. Comply with IEEE C2, "National Electrical Safety Code

E. Comply with NFPA 70.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.

B. Special Warranty for LED Sources and Drivers: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace LED sources or drivers that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Five year(s) from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LED lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Refer to Lighting Fixture Schedules (shown on the Civil drawings set electrical site plans and on the Electrical drawing set), where titles below are column headings that introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   2. Gardco: Pureform.
   3. Cooper: Gleon.
   4. All other manufacturers must be pre-approved by owner.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

Retain first paragraph below if some lighting units or luminaires are indicated to have Type I, II, III, IV, or V distribution pattern in Exterior Lighting Fixture Schedule.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's paint factory-applied to factory-assembled and -tested luminaire before shipping. Unless otherwise noted, match finish process and color of pole or support materials.

2.3 LED SOURCES


B. LED sources shall have a color temperature of 4000K (unless specified differently) and a minimum CRI of 70, with an R9 value of >0.

C. LED sources shall start and operate in -20°F to 104°F ambient.

D. LED sources shall be designed for ease of component replacement and end-of-life disassembly from room side. All internal components shall be assembled and pre-wired using modular electrical connections.

E. LED sources shall be RoHS compliant (Restriction of Hazardous Substances).
F. LED sources shall be binned to a 5 step MacAdam ellipse of the 3500K Planckian Locus.

G. LED products must have a minimum 5-year warranty for replacement of all components, including LED board or driver.

2.4 DRIVERS FOR LED FIXTURES

A. Driver for LED Fixtures – Description: Electronic driver shall be designed for type and quantity of LED fixtures served and for full light output. Comply with UL 8750, ANSI C62.41, Category A and the following:

1. Rated Lifetime: 50,000 hours at drive case temperature of 149 deg F.
2. Sound Rating: Class A.
3. Starting Temperature: Shall start the lamp(s) at -20°F or higher.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Standby Power Consumption: Less than 1.0 watt.
6. Power Factor: 0.90 or higher.
8. Transient Voltage Protection: Follow ANSI C62.41 to provide Category A rating or better.
10. Nonvolatile memory restores all driver settings after power failure.
11. Turn-on time: Less than 1 second.
12. Driver Output: Provide constant current driver with pulse width modulation (PWM) dimming, constant current driver with constant current reduction (CCR) dimming, or constant voltage driver with pulse width modulation (PWM) dimming as required by the LED fixture manufacturer.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
3.3 GROUNDING

A. Ground each light fixture using the equipment grounding conductor in the circuit supplying the fixture, per manufacturer’s requirements.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

END OF SECTION 26 5600
SECTION 26 9999 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 01, Commissioning Requirements, applies to this section and will require the contractor participation in the commissioning process.

C. Division 01 Section "LEED Requirements."

D. Specification sections indicating testing requirements for electrical systems or equipment.

1.2 SUMMARY

A. This Section includes testing general administrative and procedural requirements for electrical testing. Provide specific testing of electrical equipment devices, installations, and systems, as indicated in the Specifications and Drawings.

1.3 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) in Electrical Power Testing.
D. The testing firm shall only utilize full time technicians with the firm providing the testing services.

E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. Acceptable Testing Firms:

1. Northern Electrical Testing; Phone (248) 689-8980.
2. Utilities Instrumentation Services; Phone (800) 277-5740.

1.4 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests.
   1. Work shall be coordinated to safely expedite project scheduling.
   2. The testing firm shall notify the Owner's Representative, in writing, prior to commencement of any testing.

C. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Architect/Engineer. The Electrical Contractor shall correct all defects.

D. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

E. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act.
   c. Applicable state and local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. Owner's safety practices.
f. National Fire Protection Association - NFPA 70E.
g. American National Standards for Personnel Protection.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.

3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.5 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy, meeting standards set by the National Institute of Standards and Technology (NIST).

2. Dated calibration labels shall be visible on all test equipment.

3. Maintain current records which show;
   a. Dated results of instruments’ calibration and test procedures.
   b. Instrument calibration instructions and procedures for each test instrument.

B. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition to promote a safe working environment.

2. Metering equipment shall be suitable for the test being performed and be compatible with the electrical characteristics of the system under test.

3. Use of RMS measuring meters is recommended.

4. The accuracy of the field test metering equipment, used to check the calibration of the power system meter, shall be higher than that of the instrument being checked.

5. Accuracy of metering in test equipment shall be appropriate for the test being performed.
1.6 TEST REPORTS

A. A test report shall be generated for each piece of electrical equipment, device, installation, and system, as indicated in the Specifications and Drawings and shall include the following:

1. Check list of visual and mechanical inspections.
2. Test reports, including test values where applicable, for all required electrical tests.
3. Obvious indication, on the first page of the test report, where test results fall outside of the limits of recommended values.
4. Summary and interpretation of test results:
   a. Describe the problem in detail,
   b. Offer suggestions for solutions and correction.
5. Record of infrared scan and photos showing potential problem locations.
6. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection

1. Remove all necessary covers prior to scanning.
2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned
1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

2. Coordinate the timing of the visit with the Owner’s representative to perform the testing during peak operating hours.

C. Provide report indicating the following:

1. Problem area (location of "hot spot").
2. Temperature rise between "hot spot" and normal or reference area.
3. Cause of heat rise.
4. Phase unbalance, if present.
5. Areas scanned.

D. Test Parameters

1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Perform infrared surveys during periods of maximum possible loading.
4. Identify areas under test which are loaded to less than twenty percent (20%) of rated capacity.

E. Test Results

1. Identify temperature gradient issues per NETA standards. Identify where gradients fall into the following ranges:

   a. Temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation.
   b. Temperature gradients of 7°C to 15°C indicate deficiency; repair as time permits.
   c. Temperature gradients of 16°C and above indicate major deficiency; repair immediately.

END OF SECTION 26 9999

ELECTRICAL TESTING 26 9999- 5
SECTION 28 3111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

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

1.2 SUMMARY
A. Delegated Design
1. This specification is a performance-based specification and the Contractor shall be fully responsible for designing and providing the Fire Alarm System necessary to meet the specified requirements and as required by the codes associated with the building.
2. The Contract Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, device locations and profiles of units. The Contractor shall provide engineered shop drawings for review and submission to the authority having jurisdiction. Field verify and coordinate with other trades, the device and equipment locations, and cable/circuit routing.

B. Section Includes:
1. Fire-alarm control panel.
3. System smoke detectors.
8. Addressable interface device.
10. System printer.

1.3 DEFINITIONS
A. LED: Light-emitting diode.
B. NAC: Notification Appliance Circuit.
C. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION
A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
1.5 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level III minimum.
   c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer’s written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal: For notification and initiation appliances, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification and initiation appliance, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.
G. Operation and Maintenance Data: For fire-alarm systems and components 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. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control panel.
7. Copy of NFPA 25.
8. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: Transmitted electronically, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project, with a minimum NICET certification of Fire Alarm Level II.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 WARRANTY

A. Special Warranty for Fire Alarm System: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period. Manufacturer may exclude lightning damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period: Two years from date of Substantial Completion.
1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Construction Manager no fewer than five days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Construction Manager’s written permission.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Strobe Units: Quantity equal to 10 percent of amount installed, no more than 10, but no fewer than 1 unit.
2. Smoke Detectors and Heat Detectors: Quantity equal to 10 percent of amount of each type installed, no more than 10, but no fewer than 1 unit of each type.
3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Keys and Tools: One extra set for access to locked and tamper-proofed components.
5. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Edwards System Technologies.
3. Simplex – JCI
4. Cintas Fire Protection
2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

2. Heat detectors.
3. Smoke detectors.
   a. Spot type
4. Automatic sprinkler system water flow.
5. Fire-extinguishing system operation.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
   a. Visible notification appliances shall operate until FACP is reset.
   b. Audible notification appliances shall be capable of being manually reset.
2. Identify alarm at fire-alarm control panel and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   a. Where return air duct or plenum capacity is 2000 CFM (0.9 cubic m/s) or more, de-energize heating, ventilating, and air-conditioning equipment serving zone where alarm was initiated.
   b. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
   c. Transmit alarm signal per air-handling zone to building energy management system.
8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
10. Recall elevators to primary or alternate recall floors.
11. Activate emergency lighting control.
13. Record events in the system memory.
14. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control panel.
4. Ground or a single break in fire-alarm control panel internal circuits.
5. Abnormal ac voltage at fire-alarm control panel.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control panel or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control panel and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL PANEL

A. General Requirements for Fire-Alarm Control Panel:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control panel.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
   d. Interface modules.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 2 lines of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
2. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
D. Notification Appliance Circuit: Match Washburn University standard.

E. Elevator Recall:
   1. Smoke detectors at the following locations shall initiate automatic elevator recall. The following devices shall initiate elevator recall:
      a. Elevator lobby detectors except the lobby detector on the designated floor.
      b. Smoke detector in elevator machine room.
      c. Smoke detectors in elevator hoistway.
   2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
   3. On standby power, only one elevator shall operate at a time.
   4. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
      a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices: Install no more devices on the circuit than recommended by the manufacturer, while leaving 25% spare capacity on the circuit. Devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station at the Public Safety Building. Provide two SMF to the MDF room.

I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control panel.
   1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
      a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
      b. Programmable tone and message sequence selection.
      c. Standard digitally recorded messages for "Evacuation" and "All Clear."
      d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control panel.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.

3. Pre-amplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2. Battery and Charger Capacity: Comply with NFPA 72, but not less than 24 hours normal operation and 30 minutes alarm operation.
3. Housing: Size FACP housing to accommodate batteries without use of separate enclosures.

L. Surge Protection:

1. Install surge protection on normal ac power for FACP and its accessories.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to building housing FACP.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control panel.

   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control panel for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control panel to operate at 135 or 155 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.


7. Ambient temperature rating -4˚F to +152˚F.
2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 degree F or a rate of rise that exceeds 15 degree F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 degree F.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.
   1. Rated Light Output:
      a. 15 cd, unless otherwise indicated on the Drawings.
      b. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.

D. Weatherproof Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing operating mechanism behind bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet (3 m) from bell. 10-inch (254-mm) size, unless otherwise indicated.
E. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated. Units shall have a 3.625" minimum depth from the wall.
3. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

C. Interactive Graphic Display annunciation panel -

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, to circuit-breaker shunt trip for power shutdown and to lighting control dimming system for egress lighting, to heating, ventilating, and air conditioning equipment controllers for power shutdown, to close smoke dampers and to release magnetic door holders, electric locks, and coiling doors and grilles, to transmit signal to building management systems.

C. Provide one interface device for each individual tamper and flow switch.
2.11 NAC PANELS

A. General Description: Power-limited design, UL 864 listed.

B. Notification-Appliance Circuits: NFPA 72, Class and Style to match FACP.

C. Alarm Silencing: On-untiil-silenced for horns, on-untiil-reset for visible notification appliances. Reset and silence switches located at FACP and remote annunciators.

D. Synchronize visual notification appliances.

E. System Layout: Load notification-appliance circuits no more than 70 percent of rated capacity.

F. Total Rated NAC Current: 8 amps.

G. Primary Power: 24-V dc obtained from standby power 120-V ac service and a power-supply module. Notification appliances shall be powered by the 24-V dc source.

H. Alarm current draw of entire NAC panel shall not exceed 80 percent of power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

J. Batteries: Sealed lead calcium.

K. Battery and Charger Capacity: Comply with NFPA 72, but not less than 24 hours normal operation and 30 minutes alarm operation.

L. Power supply/charger shall be supervised for power loss, brownout, batteries, and ground faults.

M. Surge Protection:
   1. Install surge protection on normal ac power for NAC panel.
   2. Install surge protectors recommended by NAC panel manufacturer. Install on all system wiring external to building housing NAC panel.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically connect to one of two campus central station alarm network fiber cables. When contact is made with central station(s), signals shall be transmitted. If the connection is lost for longer than 30 seconds, the transmitter shall initiate a local trouble signal and transmit the signal indicating loss of data line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report data service restoration to the central station. If service is lost on both network fiber lines, transmitter shall initiate the local trouble signal.
C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
5. Communications failure with the central station or fire-alarm control panel.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address or Zone of the supervisory signal.
3. Address or Zone of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity shall comply with NFPA 72 requirements, but not less than 24 hours.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, No. 18 AWG.


1. Low-Voltage Circuits: No. 14 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, galvanized steel armor with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.
4. Plenum Cable: Listed and labeled for plenum use.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install wall-mounted fire-alarm control panel with tops of cabinets not more than 72 inches above the finished floor.
C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

D. Smoke- or Heat-Detector Spacing:
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

E. For Boiler Rooms and Kitchens, provide 190 degree F (88 degree C) fixed heat detectors.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
1. Furnish and install duct smoke detectors associated with air handling equipment and life safety dampers, fire alarm communication modules, power, and all necessary wiring. Refer to mechanical floor plans and temperature control drawings for life safety damper locations and duct detectors associated with air handling units. Provide the quantity of duct detectors recommended by the manufacturer for the installed duct configuration.

G. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

I. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
1. Install in ceiling below duct smoke detectors.
2. Locate in public space near the device that they monitor. Do not install in normally unoccupied spaces.

J. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

M. Fire-Alarm Control Panel: Mount with tops of cabinets not more than 72 inches above the finished floor.

N. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

O. NAC Panels: Provide quantity of NAC panels requires for notification appliances indicated.
   1. Provide a smoke detector in ceiling above each NAC panel.
   2. Provide 120V, 20amp AC circuit to each NAC panel.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
   1. NECA 1.
   2. TIA/EIA 568-A.
   3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.

B. Wall mounted conduit below 10’ in open ceiling areas and below ceilings in finished areas shall be concealed.

C. Wiring Method: Install wiring in conduit or provide NFPA 70, Type MC cable. Do not use open cable wiring methods.
   1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with fire alarm system, may not contain any other wire or cable.
   2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in same cable or raceway as signaling line circuits.

E. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire alarm system to terminal blocks. Mark each terminal according to system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

F. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

G. Color-Coding: Color-code fire alarm conductors differently from normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits.
Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (Metric designator 27) conduit between the FACP and transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Smoke dampers in air ducts of designated air-conditioning duct systems.
3. Alarm-initiating connection to elevator recall system and components.
4. Alarm-initiating connection to activate emergency lighting control.
5. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
6. Supervisory connections at valve supervisory switches (including automatic sprinkler system water flow, valve tampers, and positive indicator valve tampers).
7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
8. Supervisory connections at kitchen hood fire extinguishing system.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control panel.

3.4 PROGRAMMING

A. Program the fire alarm system to function as indicated and per code.

B. Program the fire alarm system to recognize the location of the unit in alarm. The alarmed unit or zone shall be displayed in the alphanumeric display per the Owner’s direction, using the Owner’s final room numbering, room naming convention or area of the building which will allow easy identification of the unit in alarm.
C. Program the fire alarm system to recognize the location of each addressable unit using per the Owners direction, using the Owner’s final room numbering, room naming convention or area of the building which will allow easy identification of addressable unit.

3.5 GROUNDING

A. Ground fire-alarm control panel, NAC panels, and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control panel and NAC panels.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

   a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its “Completion Documents, Preparation” Table in the “Documentation” Section of the “Fundamentals of Fire Alarm Systems” Chapter.

   b. Comply with “Visual Inspection Frequencies” Table in the “Inspection” Section of the “Inspection, Testing and Maintenance” Chapter in NFPA 72; retain the “Initial/Reacceptance” column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer’s written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test visible appliances for the public operating mode according to manufacturer’s written instructions.


E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 3111