PROJECT MANUAL

FOR

DETROIT DIESEL MET 1 LAB RENO

PROJECT NUMBER: 2025-DD016-001

DETROIT DIESEL

12200 TELEGRAPG RD
REDFORD CHARTER TWP, MI 48239

ISSUED FOR: BIDS; APRIL 24, 2026

PREPARED BY:

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SECTION 000115
LIST OF DRAWING SHEETS

1.01 CONTRACT DRAWINGS

A. THE FOLLOWING DRAWINGS, MARKED AND DATED AS NOTED BELOW, FOR A PART OF THE CONTRACT DOCUMENTS:

1. **MARKED: ISSUED FOR: BIDS**
2. **DATED: APRIL 24, 2026**
3. **LIST: REFER TO DRAWINGS G-011 FOR COMPLETE LIST OF DRAWINGS.**

END OF SECTION 000115

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SECTION 011000
SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: Detroit Diesel M1 Met Lab Renovation.

B. Owner's Name: Detroit Diesel.

C. Architect's Name: HED.

D. The Project consists of the alteration of M1 LABS..

1.02 DESCRIPTION OF ALTERATIONS WORK

A. Scope of demolition and removal work is indicated on drawings and specified in Section 024100.

B. Scope of alterations new work is indicated on drawings.

1.03 WORK BY OWNER

A. Owner will supply and install the following:

B. Owner will supply the following for installation by Contractor:

1.04 OWNER OCCUPANCY

A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.

B. Owner intends to occupy the Project upon Substantial Completion.

C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

D. Schedule the Work to accommodate Owner occupancy.

1.05 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to areas noted on Drawings.
   1. Locate and conduct construction activities in ways that will limit disturbance to site.

B. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.

C. Utility Outages and Shutdown:
   1. Limit disruption of utility services to hours the building is unoccupied.
   2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
   3. Prevent accidental disruption of utility services to other facilities.

1.06 WORK SEQUENCE

1.07 SPECIFICATION SECTIONS APPLICABLE TO EVERY CONTRACT

A. Unless otherwise noted, provisions of the sections listed below apply to every contract. Specific items of work listed under individual contract descriptions constitute exceptions.

B. Section 012200 - Unit Prices.

C. Section 012500 - Substitution Procedures.

D. Section 013000 - Administrative Requirements.

E. Section 014000 - Quality Requirements.
F. Section 016000 - Product Requirements.
G. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
H. Section 017000 - Execution and Closeout Requirements.
I. Section 017800 - Closeout Submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 011000

SECTION 012200
UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. List of unit prices, for use in preparing Bids.

B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

C. Defect assessment and non-payment for rejected work.

1.02 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

1.03 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.04 MEASUREMENT OF QUANTITIES

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Take all measurements and compute quantities. Measurements and quantities will be verified by Architect.

C. Assist by providing necessary equipment, workers, and survey personnel as required.

D. Measurement by Area: Measured by square dimension using mean length and width or radius.

E. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.

F. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work.

G. Contractor's Engineer Responsibilities: Sign surveyor's field notes or keep duplicate field notes , calculate and certify quantities for payment purposes.

1.05 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products not completely unloaded from the transporting vehicle.
   4. Products placed beyond the lines and levels of the required Work.
   5. Products remaining on hand after completion of the Work.
   6. Loading, hauling, and disposing of rejected Products.

1.06 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not complying with specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct one of the following remedies:

C. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.

D. The authority of Architect to assess the defect and identify payment adjustment is final.

1.07 SCHEDULE OF UNIT PRICES

A. Unit Price: Concrete Slab Preparation for Finish Flooring:

1. Description: Where concrete slab does not meet specified moisture testing requirements, provide remedial floor preparation. Preparation shall include finish flooring manufacturer recommended and approved surface applied sealer/moisture barrier and all related and required surface preparation. Such remediation shall be as required for finish flooring manufacturer to fully warrant any finish flooring adhesion failures for a period of one year after substantial completion of the Project. Any finish flooring adhesion failure during this time period shall be replaced or repaired without cost to the Owner.
2. Unit of Measurement: Per square foot (s.f.) of floor slab area requiring remediation.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012200

SECTION 012500
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

A. Section 012200 - Unit Prices, for additional unit price requirements.

B. Section 013000 - Administrative Requirements: Submittal procedures, coordination.

C. Section 016000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

D. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Restrictions on emissions of indoor substitute products.

1.03 DEFINITIONS

A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
   1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
      a. Unavailability.
      b. Regulatory changes.
   2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
      a. Substitution requests offering advantages solely to the Contractor will not be considered.

1.04 REFERENCE STANDARDS

A. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage); Current Edition.

B. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase); Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
   4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   5. Waives claims for additional costs or time extension that may subsequently become apparent.
   6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.

B. A Substitution Request for specified installer constitutes a representation that the submitter:
   1. Has acted in good faith to obtain services of specified installer, but was unable to come to commercial, or other terms.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
   1. Show compliance with requirements for substitutions and the following, as applicable.
      a. Statement indicating why specified material or product cannot be provided.
      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. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
      g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
      h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
      i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
      j. Cost information, including a proposal of change, if any, in the Contract Sum.
      k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
      l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
   2. Note explicitly any non-compliant characteristics.
   3. Product Presentation: If requested by Architect, conduct a presentation at the Architect's office to prove appropriateness to the specified product.

D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
   1. Forms indicated in the Project Manual are adequate for this purpose, and must be used.

E. Limit each request to a single proposed substitution item.
   1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

A. Submittal Time Restrictions:
   1. Owner will consider requests for substitutions only if submitted as "Voluntary Substitution" submitted with a bid.

2. Substitutions submitted by Bidders at the time of “Bid Submission” to the Construction Manager as "Voluntary Substitutions" will be considered during the Bidding review and negotiation process. If a substitution is accepted, an Addendum/Bulletin will be issued incorporating such substitution.

B. Submittal Form (before award of contract) to support "Voluntary Substitution" included with bid:
   1. Submit substitution requests by completing CSI/CSC Form 1.5C - Substitution Request. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

A. Submittal Form (after award of contract):
   1. Submit substitution requests by completing CSI/CSC Form 13.1A - Substitution Request (After Bidding/Negotiating). See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

B. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.

C. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
   1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
   2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
   3. Bear the costs engendered by proposed substitution of:
      a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.

D. Substitutions will not be considered under one or more of the following circumstances:
   1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
   2. Without a separate written request.
   3. When acceptance will require revisions to Contract Documents.

3.04 RESOLUTION

A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Architect will notify Contractor in writing of decision to accept or reject request.
   1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.05 ACCEPTANCE

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.06 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. Include completed Substitution Request Forms as part of the Project record. Include both approved and rejected Requests.

END OF SECTION 012500

SUBSTITUTION REQUEST

(During the Bidding/Negotiating Stage)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

A/E's REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

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Form Version: October 2017
CSI Form 1.5C

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SUBSTITUTION REQUEST

(After the Bidding/Negotiating Phase)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

_____

_____

☐ Point-by-point comparative data attached — REQUIRED BY A/E

Reason for not providing specified item: _____

_____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

_____

Savings to Owner for accepting substitution: _____ ($ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐Drawings ☐Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

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CSI Form 13.1A

SUBSTITUTION REQUEST

(After the Bidding/Negotiating Phase — Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

Attachments: ☐

A/E's REVIEW AND RECOMMENDATION

☐ Approve Substitution - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
☐ Approve Substitution as noted - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures.
☐ Reject Substitution - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: _____ Date: _____

OWNER'S REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures. Prepare Change Order.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 33 00 Submittal Procedures. Prepare Change Order.
☐ Substitution rejected - Use specified materials.

Signed by: _____ Date: _____

Additional Comments: ☐Contractor ☐Subcontractor ☐Supplier ☐Manufacturer ☐A/E

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SECTION 013000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Contractor's daily reports.

F. Coordination drawings.

G. Submittals for review, information, and project closeout.

H. Number of copies of submittals.

I. Requests for Interpretation (RFI) procedures.

J. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 016000 - Product Requirements: General product requirements.

B. Section 017000 - Execution and Closeout Requirements: Additional coordination requirements.

C. Section 017800 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

1.03 REFERENCE STANDARDS

A. AIA G716 - Request for Information; 2004.

1.04 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 017000 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Architect:
   1. Requests for Interpretation (RFI).
   2. Requests for substitution.
   3. Shop drawings, product data, and samples.
   4. Test and inspection reports.
   5. Design data.
   6. Manufacturer's instructions and field reports.
   7. Applications for payment and change order requests.
   8. Progress schedules.
   9. Coordination drawings.
   10. Correction Punch List and Final Correction Punch List for Substantial Completion.
   11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Schedule meeting after Notice of Award.

B. Attendance Required:

1. Owner.
2. Architect.
3. Contractor.

C. Agenda:
1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
5. Submission of initial Submittal schedule.
6. Designation of personnel representing the parties to Contract, _____ and Architect.
7. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.02 SITE MOBILIZATION MEETING

A. Schedule meeting at the Project site prior to Contractor occupancy.

B. Attendance Required:
1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.

C. Agenda:
1. Use of premises by Owner and Contractor.
2. Owner's requirements.
3. Construction facilities and controls provided by Owner.
4. Temporary utilities provided by Owner.
5. Survey and building layout.
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for testing.
10. Procedures for maintaining record documents.
11. Requirements for start-up of equipment.
12. Inspection and acceptance of equipment put into service during construction period.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required:
1. Contractor.
2. Owner.

3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

D. Agenda:
1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Maintenance of progress schedule.
7. Corrective measures to regain projected schedules.
8. Planned progress during succeeding work period.
9. Maintenance of quality and work standards.
10. Effect of proposed changes on progress schedule and coordination.
11. Other business relating to work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 DAILY CONSTRUCTION REPORTS

A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.

B. In addition to transmitting electronically a copy to Owner and Architect, submit two printed copies at weekly intervals.
1. Submit in format acceptable to Owner.

C. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
1. Date.
2. High and low temperatures, and general weather conditions.
3. List of subcontractors at Project site.
4. List of separate contractors at Project site.
5. Safety, environmental, or industrial relations incidents.
6. Meetings and significant decisions.
7. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
8. Directives and requests of Authority(s) Having Jurisdiction (AHJ).
9. Change Orders received and implemented.
10. Testing and/or inspections performed.
11. Signature of Contractor's authorized representative.

3.05 COORDINATION DRAWINGS

A. Provide information required by Project Coordinator for preparation of coordination drawings.

B. Review drawings prior to submission to Architect.

3.06 REQUESTS FOR INTERPRETATION (RFI)

A. Definition: A request seeking one of the following:

1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.
   2. Prepare in a format and with content acceptable to Owner.
      a. Use AIA G716 - Request for Information .
   3. Combine RFI and its attachments into a single electronic file. PDF format is preferred.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
      a. Approval of submittals (use procedures specified elsewhere in this section).
      b. Approval of substitutions (see Section - 016000 - Product Requirements)
      c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
      d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
   3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
   4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
      a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
   1. Official Project name and number, and any additional required identifiers established in Contract Documents.
   2. Owner's, Architect's, and Contractor's names.
   3. Discrete and consecutive RFI number, and descriptive subject/title.
   4. Issue date, and requested reply date.
   5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).

6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
2. Note dates of when each request is made, and when a response is received.
3. Highlight items requiring priority or expedited response.
4. Highlight items for which a timely response has not been received to date.
5. Identify and include improper or frivolous RFIs.

H. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.07 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format.
1. Submit at the same time as the preliminary schedule.
a. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
b. Submit revised submittal schedule to reflect changes in current status and timing for submittals concurrently with the first complete submittal of Contractor's construction schedule.
2. Coordinate with Contractor's construction schedule and schedule of values.
3. Format schedule to allow tracking of status of submittals throughout duration of construction.

4. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
    a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.08 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
    1. Product data.
    2. Shop drawings.
    3. Samples for selection.
    4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.09 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
    1. Design data.
    2. Certificates.
    3. Test reports.
    4. Inspection reports.
    5. Manufacturer's instructions.
    6. Manufacturer's field reports.
    7. Qualification data.
    8. Maintenance data.
    9. Other types indicated.

B. Submit for Architect's knowledge as contract administrator or for Owner.

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
    1. Project record documents.
    2. Operation and maintenance data.
    3. Warranties.
    4. Bonds.
    5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.11 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
   1. Contractor shall retain one copy of file as an electronic Project record document file at the Project Site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.12 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Submission of separate specification sections in one submittal is not allowed unless materials specified in separate sections are integral to the submittal.
   3. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   4. Transmit using approved form.
      a. Refer to Section 013300.03, “Administrative Requirements, Appendix 03”, for a sample transmittal form that contains all information required. The sample transmittal form is available in Microsoft Word format for Contractor’s use. Contractor’s form may be used if all required information is provided.
   5. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   6. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   7. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
      a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
   8. Deliver or transmit submittal on date noted in submittal schedule, unless an earlier date been agreed to by all affected parties, and is of the benefit to the project. Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Transmittal must be electronically signed by the Contractor certifying submittal, to the best of the Contractor’s knowledge, is in compliance with Contract Documents except as noted. Architect will return without review submittals received from sources other than Contractor.
      a. Place a permanent label or title block on each submittal item for identification.
      b. Refer to Appendix 013300.02, “Contractor’s Submittal Label Information”, for sample label. Sample is shown completely filled out for clarification. Size of label is optional but all information shown shall be included and shall be easily read.
      c. 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.
      d. Deliver hard copy or sample submittals to Architect at business address; Attention: Contract Administration.
      e. Send submittals in electronic format via email to Architect.

9. Schedule submittals to expedite the Project, and coordinate submission of related items. 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.
    a. For each submittal and re-submittal for review, allow 10 working days excluding delivery time to and from the Contractor.
    b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
        1) Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
    c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 calendar days.
    d. Submittals received by 10:00 am will be marked as received on that day. Submittals received after 10:00 am will be marked as received on the next working day.
10. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
11. Identify options requiring selection by Architect.
12. Provide space on label or beside title block for Contractor review stamps. Include the following information for processing and recording action taken:
    a. Project name.
    b. Architect’s project number and Owner’s account/project number, if applicable.
    c. Date.
    d. Name and address of Architect.
    e. Name and address of Contractor.
    f. Name and address of subcontractor.
    g. Name and address of supplier.
    h. Name of manufacturer.
    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Name of drawing preparer not initials.
    l. Name of person and company preparing submittals.
    m. Other necessary identification.
13. When revised for resubmission, identify all changes made since previous submission.
    a. Reviewing of resubmitted Shop Drawings by the Architect shall be limited to required corrections only, and the Contractor or Subcontractor by resubmitting shall be held to represent that the resubmitted Shop Drawings contain no other alterations, additions or deletions. If additional changes have been made, same shall be specifically noted and described on the Shop Drawing and/or in the covering transmittal.
    b. Architect’s services beyond those stipulated in the Owner/Architect Agreement may be a cause for the Owner to impose reimbursement by the Contractor for these additional services performed by the Architect. As a guide to establish limits of these services and provide a base for the Contractor to use in preparing its Bid, the following limits shall apply:
        1) Up to two (2) reviews for each Shop Drawing, Product Data item, Sample and similar submittals.
14. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
15. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.

16. Submittals not requested will not be recognized, and will be returned "Submittal Not Requested (SNR)".
17. Fabrication commenced prior to completion of review by Architect shall be at the sole risk of the Contractor.

B. Product Data Procedures:
1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal unless partial submittals for portions of the Work are indicated on approved submittal schedule.
4. Do not submit (Material) Safety Data Sheets for materials or products
a. .Submit Material Data Safety Sheets to Owner if requested.

C. Shop Drawing Procedures:
1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Use of reproductions of Contract Documents in digital data form to create shop drawings is only permitted with Architect approval.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.
3. Include with transmittal high-resolution image files of samples to facilitate electronic review and approval. Provide separate submittal page for each item image.

3.13 SUBMITTAL REVIEW

A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
1. Refer to Section 013300.01, “Administrative Requirements Appendix 01”, for sample action stamp.
2. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.

D. Architect's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:
a. "Reviewed (R)", or language with same legal meaning.
1) Proceed on Basis of Information Received.
b. ""Reviewed as Noted (RAN)"", or language with same legal meaning.
1) Proceed on Basis of Revised Information Noted.
c. ""Reviewed and Resubmit for Record (RRR)", or language with same legal meaning.
1) Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.
2. Not Authorizing fabrication, delivery, and installation:
a. "Provide as Specified (PAS)".

1) Work shall not proceed based on non-specified information submitted. Resubmit.

b. "Revise and Resubmit (RR)".

1) Work shall not proceed based on non-specified information submitted. Resubmit.

E. Architect's and consultants' actions on items submitted for information:

1. Items for which no action was taken:
   a. "Received" - to notify the Contractor that the submittal has been received for record only.
2. Items for which action was taken:
   a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

SECTION 013000.01 - ADMINISTRATIVE REQUIREMENTS APPENDIX 01

ARCHITECT'S ACTION STAMP SAMPLE

HED

Submittal Review

Architect/Engineer's review is for general conformance with the design concept and the intent of the contract documents. Markings or comments shall not be construed as relieving the Contractor from compliance with the project plans and specifications, nor departure therefrom. The Contractor remains responsible for details and accuracy. This review does not authorize any additional cost or schedule change. Refer to the Contract Documents relative to submittals for clarification of Contractor responsibility.

HED Project Number/Name: _____

Submittal Number: _____

Discipline	Reviewer	Date	Remarks Attached
A+D			☐
Civil / Site			☐
Structural			☐
Interiors			☐
Mechanical			☐
Electrical			☐
			☐

☐	Reviewed (R) Work May Proceed	☐	Reviewed & Resubmit for Record (RRR) Work May Proceed. Revise & Resubmit for Record.
☐	Reviewed as Noted (RAN) Work May Proceed on Basis of Revised Information Noted	☐	Revise & Resubmit (RR) Work Shall Not Proceed Based on Information Submitted. Revise & Resubmit.
☐	Submittal Not Requested / Not Reviewed (SNR)	☐	Provide as Specified (PAS) Work Shall Not Proceed Based on Non-Specified Information Submitted. Revise & Resubmit.

Final Action / Selection for Contractor:

Final Review By: Date:

END OF SECTION 013000.01

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SECTION 013000.02 - ADMINISTRATIVE REQUIREMENTS APPENDIX 02

CONTRACTOR'S SUBMITTAL LABEL INFORMATION SAMPLE

Project	Project Name
Architect's Project No.	Project Number
Date	Date
Architect	HED Address City, State, Zip
General Contractor (Construction Manager) Address, phone number	Name Address City, State, Zip Phone
Subcontractor Address, phone number	Name Address City, State, Zip Phone
Supplier/Manufacturer Address, phone number	Name Address City, State, Zip Phone
Drawn By (name, not initials)	Name
Specification No. and Title	081113, Hollow Metal Doors and Frames
Drawing No.	A-1
Detail Reference (if applicable)	1/A-501
Name of person and company preparing submittal	Name Company

END OF SECTION 013000.02

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(Contractor's Logo
and address here)

SUBMITTAL TRANSMITTAL

Project: _____

Architect's Project No.: _____
Contractor's Project No.: _____
Date Sent to Arch.: _____
Date Returned to Contr.: _____

To: HED
Address
City, State, Zip

Attn: Construction Administration

Returned Via:
___ UPS Standard Ground
___ UPS / FedEx Overnight (Purchase Order required)
___ Your Messenger

Submittal Description:

Specification Section No.:	Items Submitted: Shop Drawings, Product Data, Samples, Maint. Manuals, Etc.	Fabricator / Supplier:	Review Code *:	Arch. Submittal Log. No.:
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Deviations, Minor Variations and Limitations: _____

The Contractor certifies that it has examined the items submitted by this transmittal and finds that they are, to the best of its knowledge, in compliance with the Contract Documents.

By: _____ Date: _____
(Signature required)

HED Reviewer's Remarks:

The information submitted has been reviewed for compliance with the Contract Documents. The review and the resulting notations do not assume completeness of the submittal nor suggest that information not requested is waived. Further, the review does not relieve the Contractor from the satisfactory completion of the Work in compliance with the Contract Documents.

HED
By: _____ Date: _____
(Signature Required)

* Review Codes:

R	Reviewed:	Work May Proceed.
RAN	Reviewed As Noted:	Proceed on Basis of revised Information Noted.
RR	Revise & Resubmit:	Work Shall Not Proceed Based on Information Submitted. Resubmit.
RRR	Reviewed & Resubmit for Record:	Work May Proceed. Revise & Resubmit for Record.
SNR	Submittal Not Requested:	Not Reviewed or Retained by the Architect.
PAS	Provide as Specified:	Work Shall Not Proceed Based on Non-Specified Information. Resubmit.

HED Routing:

Primary Checker: _____

Secondary Checkers: _____ _____ _____ _____

Submittal Received by Architect:

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SECTION 014000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.
B. Quality assurance.
C. References and standards.
D. Testing and inspection agencies and services.
E. Contractor's design-related professional design services.
F. Control of installation.
G. Mock-ups.
H. Tolerances.
I. Manufacturers' field services.
J. Defect Assessment.

1.02 RELATED REQUIREMENTS

A. Section 012100 - Allowances: Allowance for payment of testing services.
B. Section 013000 - Administrative Requirements: Submittal procedures.
C. Section 016000 - Product Requirements: Requirements for material and product quality.

1.03 DEFINITIONS

A. Contractor's Quality Control Plan: Contractor's management plan for executing the Contract for Construction.
B. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
    1. Design Services Types Required:
        a. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
C. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.04 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
B. Base design on performance and/or design criteria indicated in individual specification sections.
C. Scope of Contractor's Professional Design Services: Provide for the following items of work:
    1. Structural Design: Include physical characteristics, engineering calculations, and resulting dimensional limitations as described in Section 084313 - Aluminum-Framed Storefronts.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Designer's Qualification Statement: Submit for Architect's knowledge as contract administrator, or for Owner's information.
   1. Include information for each individual professional responsible for producing, or supervising production of, design-related professional services provided by Contractor.
      a. Full name.
      b. Professional licensure information.
      c. Statement addressing extent and depth of experience specifically relevant to design of items assigned to Contractor.

C. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
   1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
   2. Include required product data and shop drawings.
   3. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.
   4. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.

D. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of test/inspection.
      h. Date of test/inspection.
      i. Results of test/inspection.
      j. Compliance with Contract Documents.
      k. When requested by Architect, provide interpretation of results.
   2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

E. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
   1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
   2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.

F. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

G. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.

1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

H. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications:
1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.

B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.08 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Owner will employ services of an independent testing agency to perform certain specified testing;

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 MOCK-UPS

A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.

B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.

C. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be constructed.

D. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.

E. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.

F. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

G. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
   1. Architect will issue written comments within seven (7) working days of initial review and each subsequent follow up review of each mock-up.
   2. Make corrections as necessary until Architect's approval is issued.

H. Architect will use accepted mock-ups as a comparison standard for the remaining Work.

I. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

2.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

2.04 TESTING AND INSPECTION

A. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.

E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

2.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and _____ to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

2.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION 014000

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SECTION 014533
CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Code or Building Code: ICC (IBC), International Building Code, most recent edition adopted by authority having jurisdiction, including all applicable amendments and supplements without limitation, and specifically Chapter 17 - Special Inspections and Tests.

B. Special Inspections and Tests: Inspections and testing of materials, installation, fabrication, erection, or placement of components and connections mandated by Building Code to safeguard public welfare.
   1. Special inspections and tests are separate from and independent of tests and inspections conducted by Owner or Contractor for purposes of quality assurance and contract administration.

1.02 REFERENCE STANDARDS

A. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2025.

B. IAS AC291 - Accreditation Criteria for Special Inspection Agencies AC291; 2025, with Editorial Revision.

C. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

1.04 QUALITY ASSURANCE

A. Special Inspection Agency Qualifications:
   1. Independent firm specializing in performing testing and inspections of the type specified in this section.
   2. Accredited by IAS according to IAS AC291.

B. Testing Agency Qualifications:
   1. Independent firm specializing in performing testing and inspections of the type specified in this section.
   2. Accredited by IAS according to IAS AC89.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS AND TESTING

A. The Code requires special inspections and testing of certain materials, components, assemblies, and connections used in constructing the project. Special inspections and testing will be performed in accordance with the Code.

END OF SECTION 014533

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SECTION 016000
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Re-use of existing products.

C. Transportation, handling, storage and protection.

D. Product option requirements.

E. Substitution limitations.

F. Procedures for Owner-supplied products.

G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

A. Section 012500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

B. Section 014000 - Quality Requirements: Product quality monitoring.

C. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

D. Section 017419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

E. Section 220513 - Common Motor Requirements for Plumbing Equipment: Motors for plumbing equipment.

F. Section 230513 - Common Motor Requirements for HVAC Equipment: Motors for HVAC equipment.

1.03 REFERENCE STANDARDS

A. NEMA MG 00001 - Motors and Generators; 2024.

1.04 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
   1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.

B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.

C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

D. Specific Products to be Reused: The reuse of certain materials and equipment already existing on the project site is not prohibited.
   1. If applicable, see drawings for list of items required to be salvaged for reuse and/or relocation.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. See Section 014000 - Quality Requirements, for additional source quality control requirements.

C. Use of products having any of the following characteristics is not permitted:
   1. Made using or containing CFC's or HCFC's.
   2. Containing lead, cadmium, or asbestos.

D. Where other criteria are met, Contractor shall give preference to products that:
   1. If used on interior, have lower emissions, as defined in Section 016116.
   2. If wet-applied, have lower VOC content, as defined in Section 016116.

E. Motors: Refer to Section 220513 - Common Motor Requirements for Plumbing Equipment, NEMA MG 00001 Type. Specific motor type is specified in individual specification sections.

F. Motors: Refer to Section 230513 - Common Motor Requirements for HVAC Equipment, NEMA MG 00001 Type. Specific motor type is specified in individual specification sections.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.04 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 012500 - Substitution Procedures.

3.02 OWNER-SUPPLIED PRODUCTS

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.

3. On delivery, inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
1. Review Owner reviewed shop drawings, product data, and samples.
2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
3. Handle, store, install and finish products.
4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

A. Provide protection of stored materials and products against theft, casualty, or deterioration.

B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 017419.
1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.

C. Store and protect products in accordance with manufacturers' instructions.

D. Store with seals and labels intact and legible.

E. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

F. For exterior storage of fabricated products, place on sloped supports above ground.

G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

H. Comply with manufacturer's warranty conditions, if any.

I. Do not store products directly on the ground.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Prevent contact with material that may cause corrosion, discoloration, or staining.

L. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

M. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 016000

SECTION 016116
VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for Indoor-Emissions-Restricted products.

B. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittal procedures.

B. Section 014000 - Quality Requirements: Procedures for testing and certifications.

C. Section 016000 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

D. Section 079200 - Joint Sealants: Emissions-compliant sealants.

1.03 DEFINITIONS

A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.
   3. Flooring.
   4. Products making up wall and ceiling assemblies.
   5. Thermal and acoustical insulation.
   6. Other products when specifically stated in the specifications.

B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.

C. Interior of Building: Anywhere inside the exterior weather barrier.

D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.

E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:
   1. Concrete.
   2. Clay brick.
   3. Metals that are plated, anodized, or powder-coated.
   4. Glass.
   5. Ceramics.
   6. Solid wood flooring that is unfinished and untreated.

1.04 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2025.

C. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2020.

D. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).

E. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.06 QUALITY ASSURANCE

A. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
   1. Evidence of Compliance: Acceptable types of evidence are:
      a. Report of laboratory testing performed in accordance with requirements.
      b. Published product data showing compliance with requirements.
      c. Certification by manufacturer that product complies with requirements.

B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. VOC-Content-Restricted Products: VOC content not greater than required by the following:
   1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
   2. Joint Sealants: SCAQMD 1168 Rule.
   3. Paints and Coatings: Each color; most stringent of the following:
      a. 40 CFR 59, Subpart D.
      b. SCAQMD 1113 Rule.
      c. CARB (SCM).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.

B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 016116

SECTION 017000
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Requirements for alterations work, including selective demolition, _____.

C. Pre-installation meetings.

D. Cutting and patching.

E. Surveying for laying out the work.

F. Cleaning and protection.

G. Starting of systems and equipment.

H. Demonstration and instruction of Owner personnel.

I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

J. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittals procedures, Electronic document submittal service.

B. Section 014000 - Quality Requirements: Testing and inspection procedures.

C. Section 015000 - Temporary Facilities and Controls: Temporary exterior enclosures.

D. Section 015000 - Temporary Facilities and Controls: Temporary interior partitions.

E. Section 017419 - Construction Waste Management and Disposal: Additional procedures for trash/waste removal, recycling, salvage, and reuse.

F. Section 017800 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.

G. Section 017900 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections

H. Section 078400 - Firestopping.

1.03 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
   1. On request, submit documentation verifying accuracy of survey work.
   2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in compliance with Contract Documents.
   3. Submit surveys and survey logs for the project record.

C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.

2. Integrity of weather exposed or moisture resistant element.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements.
5. Work of Owner or separate Contractor.

1.05 QUALIFICATIONS

A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

B. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 QUALITY ASSURANCE

A. Do not cut and patch structural work in a manner that could result in a reduction of load carrying capacity or an increase in the structure’s deflection. Obtain approvals from the Owner, Engineer of Record and Architect before cutting and patching any structural member or assembly.
   1. EXCEPTION: Modifications to structural work done in accordance with specific details included in the Contract Documents stamped by the Engineer of Record and approved by the Authorities Having Jurisdiction in the State in which the Project is located.

B. Do not cut and patch operational elements or safety related components in a manner resulting in a reduction of capacities to perform in a manner intended or resulting in a decreased operational life, increased maintenance, or decreased safety.

1.07 PROJECT CONDITIONS

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.

C. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.

D. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.08 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Architect four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of examination, preparation and installation procedures.
   2. Review coordination with related work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Architect of any discrepancies discovered.

C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

D. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.

F. Utilize recognized engineering survey practices.

G. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations; and _____.
   2. Grid or axis for structures.
   3. Building foundation, column locations, ground floor elevations, and _____.

H. Periodically verify layouts by same means.

I. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as indicated.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of alterations work constitutes acceptance of existing conditions.

B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions.
   2. Provide sound retardant partitions of construction indicated on drawings in locations indicated on drawings.

C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
   1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.

2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.

D. Remove existing work as indicated and as required to accomplish new work.
   1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings.
   3. Relocate items indicated on drawings.
   4. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
   5. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.

E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and _____): Remove, relocate, and extend existing systems to accommodate new construction.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
   2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
   3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
      a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
      b. Provide temporary connections as required to maintain existing systems in service.
   4. Verify that abandoned services serve only abandoned facilities.
   5. Remove abandoned pipe, ducts, conduits, and equipment , including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.

G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
   1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
   2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
   3. Where a change of plane of 1/4 inch (6 mm) or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.
   4. Trim existing wood doors as necessary to clear new floor finish. Refinish trim as required.

H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

I. Refinish existing surfaces as indicated:
   1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
   2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
   3. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.
   4. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   5. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

J. Clean existing systems and equipment.

K. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

L. Do not begin new construction in alterations areas before demolition is complete.

M. Comply with all other applicable requirements of this section.

3.07 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

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

D. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.
   7. Remove samples of installed work for testing when requested.
   8. Remove and replace defective and non-complying work.

E. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

F. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

G. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

H. Restore work with new products in accordance with requirements of Contract Documents.

I. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

J. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 078400, to full thickness of the penetrated element.

K. Patching:
   1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   2. Match color, texture, and appearance.
   3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.08 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

E. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

F. Waste Disposal: Do not wash waste materials down sewers or into waterways.

3.09 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

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

3.11 DEMONSTRATION AND INSTRUCTION

A. See Section 017900 - Demonstration and Training.

3.12 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

B. Testing, adjusting, and balancing HVAC systems: See Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.13 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, drainage systems, and _____.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.14 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to Architect and Owner.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.

D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.

E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.15 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 017000

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SECTION 017419
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.

E. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. Section 015000 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

C. Section 016000 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

D. Section 017000 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

A. See Section 013000 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 015000 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 016000 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 017000 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 017419

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SECTION 017800
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.

B. Operation and maintenance data.

C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 017000 - Execution and Closeout Requirements: Contract closeout procedures.

C. Individual Product Sections: Specific requirements for operation and maintenance data.

D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.

B. Operation and Maintenance Data:
   1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
   3. Submit two sets of revised final documents in final form within 10 days after final inspection.

C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Field changes of dimension and detail.
   2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

B. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

C. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Binders: Commercial quality, 8-1/2 by 11 inch (216 by 280 mm) three D side ring binders with durable plastic covers; 2 inch (50 mm) maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

END OF SECTION 017800

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SECTION 017900
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.

1.02 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures; except:

B. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
   1. Submit not less than four weeks prior to start of training.
   2. Revise and resubmit until acceptable.
   3. Provide an overall schedule showing all training sessions.
   4. Include at least the following for each training session:
      a. Identification, date, time, and duration.
      b. Description of products and/or systems to be covered.
      c. Name of firm and person conducting training; include qualifications.
      d. Intended audience, such as job description.
      e. Objectives of training and suggested methods of ensuring adequate training.
      f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
      g. Media to be used, such a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
   1. Include applicable portion of O&M manuals.
   2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
   3. Provide one extra copy of each training manual to be included with operation and maintenance data.

1.03 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
   1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
   2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.

C. Demonstration may be combined with Owner personnel training if applicable.

D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.
   2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

A. Conduct training on-site unless otherwise indicated.

B. Owner will provide classroom and seating at no cost to Contractor.

C. Provide training in minimum two hour segments.

D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
   1. The location of the O&M manuals and procedures for use and preservation; backup copies.
   2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
   3. Typical uses of the O&M manuals.

F. Product- and System-Specific Training:
   1. Review the applicable O&M manuals.
   2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
   3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
   4. Provide hands-on training on all operational modes possible and preventive maintenance.
   5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
   6. Discuss common troubleshooting problems and solutions.
   7. Discuss any peculiarities of equipment installation or operation.
   8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
   9. Review recommended tools and spare parts inventory suggestions of manufacturers.
   10. Review spare parts and tools required to be furnished by Contractor.
   11. Review spare parts suppliers and sources and procurement procedures.

G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 017900

SECTION 024100
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of building elements for alteration purposes.

B. Abandonment and removal of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 011000 - Summary: Sequencing and staging requirements.

C. Section 011000 - Summary: Description of items to be salvaged or removed for re-use by Contractor.

D. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

E. Section 016000 - Product Requirements: Handling and storage of items removed for salvage and relocation.

F. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

B. ASSE A10.6 - Safety and Health Program Requirements for Demolition Operations 2006 (R2016).

C. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
   1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
   2. Identify demolition firm and submit qualifications.

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

D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE

A. Remove portions of existing building as indicated on the Drawings.:

B. Remove items as indicated, for salvage and relocation.

C. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   3. Provide, erect, and maintain temporary barriers and security devices.
   4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.

3.03 EXISTING UTILITIES

A. Protect existing utilities to remain from damage.

B. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

D. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

E. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as indicated.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Separate areas in which demolition is being conducted from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions .
   2. Provide sound retardant partitions of construction indicated on drawings in locations indicated on drawings.
   3. Do not close or obstruct walkways, corridors, or other occupied or used facilities

C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

D. Remove existing work as indicated and as required to accomplish new work.
   1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings.

E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and _____): Remove existing systems and equipment as indicated.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
   2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
   3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
      f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
      g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatibleductwork material and leave in place.
   4. Verify that abandoned services serve only abandoned facilities before removal.
   5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch to match new work.

G. Comply with Owner’s requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

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

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

J. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.05 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

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

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

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

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Division 7 Sections for new roofing requirements.
   1. Remove existing roof membrane, flashings, copings, and roof accessories.
   2. Remove existing roofing system down to substrate.

3.06 PATCHING AND REPAIRS,

A. General: Promptly repair damage to adjacent construction by selective demolition operations.

B. Patching: Comply with Section 017000 - Execution and Closeout Requirements.

C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
   1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Floors and Walls: Where walls or partitions that are demolished extend one finished are into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture and appearance. Remove existing floor and wall coverings and replace with new materials if necessary, to achieve uniform color and appearance.
   1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
   2. Where patching occurs over a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
   3. Where feasible, test and inspect patched are after completion to demonstrate integrity of installation.

F. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide even-plane surface of uniform appearance.

3.07 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

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SECTION 033000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete formwork.

B. Floors and slabs on grade.

C. Concrete reinforcement.

D. Joint devices associated with concrete work.

E. Concrete curing.

1.02 REFERENCE STANDARDS

A. ACI CODE-318 - Building Code for Structural Concrete—Code Requirements and Commentary; 2025.

B. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.

C. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.

D. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

E. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.

F. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.

G. ACI PRC-308 - Guide to External Curing of Concrete; 2016.

H. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).

I. ACI SPEC-301 - Specifications for Concrete Construction; 2020.

J. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.

K. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2022.

L. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.

M. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

N. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).

O. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).

P. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.

Q. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.

R. ASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete; 2023.

S. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.

T. ASTM D471 - Standard Test Method for Rubber Property--Effect of Liquids; 2016a (Reapproved 2021).

U. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.

V. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.

W. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

X. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
   1. For chemical-resistant waterstops, provide data on ASTM D471 test results.

C. Mix Design: Submit proposed concrete mix design.
   1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
   2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
   3. Indicate proposed mix design complies with fiber reinforcing manufacturer's written recommendations.

D. Samples: Submit samples of underslab vapor retarder to be used.

E. Test Reports: Submit report for each test or series of tests specified.

F. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.

B. Follow recommendations of ACI PRC-305 when concreting during hot weather.

C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

D. For slabs required to include moisture vapor reducing admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.

PART 2 PRODUCTS

2.01 FORMWORK

A. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
   1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
   2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
   3. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches (38 mm) of concrete surface.

2.02 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa).
   1. Type: Deformed billet-steel bars.
   2. Finish: Epoxy coated in accordance with ASTM A775/A775M, unless otherwise indicated.

B. Reinforcement Accessories:
   1. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.
      a. Products:
         1) Dayton Superior Corporation: www.daytonsuperior.com/#sle.
         2) Splice Sleeve North America, Inc; NMB Splice Sleeve System: www.splicesleeve.com/#sle.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Type I - Normal Portland type.
   1. Acquire cement for entire project from same source.

B. Fine and Coarse Aggregates: ASTM C33/C33M.
   1. Acquire aggregates for entire project from same source.

C. Fly Ash: ASTM C618, Class C.

D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

E. Structural Fiber Reinforcement: ASTM C1116/C1116M.

2.04 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

B. Air Entrainment Admixture: ASTM C260/C260M.

C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.

D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.

E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.

F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.

G. Water Reducing Admixture: ASTM C494/C494M Type A.

H. Corrosion Inhibiting Admixture:

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder:
   1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
   2. Products:
      a. Henry Company; Moistop Ultra 10: www.henry.com/#sle.
      b. ISI Building Products; Viper VaporCheck II 10-mil (Class A): www.isibp.com/#sle.
      c. Tex-Trude, LP; Xtreme Vapor Barrier (10-mil): www.tex-trude.com/#sle.
      d. W. R. Meadows, Inc; PERMINATOR Class A - 10 mils (0.25 mm): www.wrmeadows.com/#sle.

2.06 BONDING AND JOINTING PRODUCTS

A. Epoxy Bonding System:
   1. Complying with ASTM C881/C881M and of Type required for specific application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Prepare existing concrete surfaces to be repaired according to ICRI 310.2R, _____.

E. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
   1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.

F. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

G. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
   1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

B. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

3.04 PLACING CONCRETE

A. Place concrete in accordance with ACI PRC-304.

B. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.05 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. Provide finish as follows:

D. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
   1. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.

3.06 CURING AND PROTECTION

A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.

3.07 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.08 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

3.09 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 033000

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SECTION 042000
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete block.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Flashings.

E. Lintels.

F. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 040511 - Mortar and Masonry Grout.

B. Section 079200 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A580/A580M - Standard Specification for Stainless Steel Wire; 2023.

C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.

D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

E. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2022.

F. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.

G. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units; 2023.

H. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; 2023a.

I. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

J. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2017.

K. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls; 2017.

L. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches (400 by 200 mm) and nominal depth of 8 inches (200 mm).
   2. Nonloadbearing Units: ASTM C129.
      a. Hollow block, as indicated.
      b. Lightweight.

2.02 MORTAR AND GROUT MATERIALS

A. Mortar and Grout: As specified in Section 040511.

2.03 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi) (280 MPa), deformed billet bars; galvanized.

B. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.

C. Strap Anchors: Bent steel shapes, 1-1/2 inch (38 mm) width, 0.105 inch (2.7 mm) thick, 24 inch (610 mm) length, with 1-1/2 inch (38 mm) long, 90 degree bend at each end to form a U or Z shape or with cross pins, hot dip galvanized to ASTM A153/A153M Class B.

D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch (16 mm) of mortar coverage from masonry face.

E. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch (4.8 mm) thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not less than 5/8 inch (16 mm) of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in (32 mm).

F. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
   1. Anchor plates: Not less than 0.075 inch (1.91 mm) thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
   2. Wire ties: Manufacturer's standard shape, 0.1875 inch (4.75 mm) thick.
   3. Vertical adjustment: Not less than 3-1/2 inches (89 mm).

2.04 FLASHINGS

A. Metal Flashing Materials:
   1. Stainless Steel Flashing: ASTM A666/A666M, Type 304, soft temper; 26 gauge, 0.0187 inch (0.48 mm) thick; finish 2B to 2D.

2.05 ACCESSORIES

A. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.

B. Weeps:
   1. Type: Polyester mesh.
   2. Color(s): black.
   3. Manufacturers:
      a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
      b. Masonry Technology, Inc; Cavity Weep: www.mtidry.com/#sle.

c. Mortar Net Solutions; WeepVent: www.mortarnet.com/#sle.

C. Cavity Vents:
1. Type: Preformed aluminum vents with sloping louvers.
2. Manufacturers:
a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
b. Hohmann & Barnard, Inc: www.h-b.com/#sle.
c. Mortar Net Solutions; CellVent: www.mortarnet.com/#sle.

D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:
1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches (200 mm).
3. Mortar Joints: Concave.

3.04 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Remove excess mortar and mortar smears as work progresses.

D. Interlock intersections and external corners, except for units laid in stack bond.

E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.05 WEEPS/CAVITY VENTS

A. Install weeps in veneer and cavity walls at 24 inches (600 mm) on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.

B. Install cavity vents in veneer and cavity walls at 32 inches (800 mm) on center horizontally below shelf angles and lintels and near top of walls.

3.06 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

3.07 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches (400 mm) on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch (16 mm) mortar cover on each side.

E. Lap joint reinforcement ends minimum 6 inches (150 mm).

F. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches (900 mm) horizontally and 24 inches (600 mm) vertically.

G. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches (38 mm) with at least 5/8 inch (16 mm) mortar cover to the outside face of the anchor.

3.08 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

A. Masonry Back-Up: Embed anchors to bond veneer at maximum 16 inches (400 mm) on center vertically and 36 inches (900 mm) on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches (200 mm) on center.

3.09 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
   1. Extend flashings full width at such interruptions and at least 6 inches (152 mm), minimum, into adjacent masonry or turn up flashing ends at least 1 inch (25.4 mm), minimum, to form watertight pan at nonmasonry construction.
   2. Remove or cover protrusions or sharp edges that could puncture flashings.
   3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.

C. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.

D. Support flexible flashings across gaps and openings.

3.10 LINTELS

A. Install loose steel lintels over openings.

B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
   1. Openings from 42 inches (1070 mm) to 78 inches (1980 mm): Place two, No. 5 (M16) reinforcing bars 1 inch (25 mm) from bottom web.
   2. Openings over 78 inches (1980 mm): Reinforce openings as detailed.
   3. Do not splice reinforcing bars.
   4. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.
   5. Place and consolidate grout fill without displacing reinforcing.
   6. Allow masonry lintels to attain specified strength before removing temporary supports.

C. Maintain minimum 8" inch (____ mm) bearing on each side of opening.

3.11 GROUTED COMPONENTS

A. Reinforce bond beams with 2, No. ____ (M____) bars, 1 inch (25 mm) from bottom web.

B. Lap splices minimum 24 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

3.12 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.

C. Size control joints as indicated on drawings; if not indicated, 3/4 inch (19 mm) wide and deep.

3.13 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation from Alignment of Columns: 1/4 inch (6 mm).

C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch (1.6 mm).

D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft (6 mm/3 m) and 1/2 inch in 20 ft (13 mm/6 m) or more.

E. Maximum Variation from Plumb: 1/4 inch (6 mm) per story non-cumulative; 1/2 inch (13 mm) in two stories or more.

F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft (3 mm/m) and 1/4 inch in 10 ft (6 mm/3 m); 1/2 inch in 30 ft (13 mm/9 m).

G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch (minus 6.4 mm, plus 9.5 mm).

H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch (6 mm).

3.14 CUTTING AND FITTING

A. Cut and fit for pipes, conduit, and sleeves. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.15 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.

3.16 CLEANING

A. Clean soiled surfaces with cleaning solution.

3.17 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 042000

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SECTION 061000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roofing nailers.

B. Concealed wood blocking, nailers, and supports.

C. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

C. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2024).

D. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing; 2019a.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

F. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.

G. PS 1 - Structural Plywood; 2009 (Revised 2019).

H. PS 20 - American Softwood Lumber Standard; 2025.

I. SPIB (GR) - Standard Grading Rules; 2021.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit technical data on wood treatment.

C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
   2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

2.03 ACCESSORIES

A. Metal and Finish of Fasteners:
   1. Untreated Wood: Type 316 stainless steel.
   2. Masonry Anchors: Toggle bolt type for anchorage to hollow masonry.

B. Anchors: Toggle bolt type for anchorage to hollow masonry.

C. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
   1. For contact with preservative treated wood in exposed locations, provide minimum G185 (Z550) galvanizing complying with ASTM A653/A653M.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.02 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.

C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

E. Provide nonstructural framing and blocking to support the following:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Handrails.
   4. Grab bars.
   5. Towel and bath accessories.
   6. Wall-mounted door stops.
   7. Chalkboards and marker boards.
   8. Wall paneling and trim.
   9. Joints of rigid wall coverings that occur between studs.
   10. Other wall- or ceiling-mounted items indicated on drawings.

3.03 TOLERANCES

A. Framing Members: 1/4 inch (6 mm) from true position, maximum.

B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

3.05 CLEANING

A. Waste Disposal: See Section 017419 - Construction Waste Management and Disposal.
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 061000

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SECTION 072119
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foamed-in-place insulation.

1.02 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

B. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

D. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

E. FM 4880 - Examination Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials; 2022.

F. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers; 2022.

G. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2024.

H. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction; Current Edition, Including All Revisions.

I. UL 1715 - Standard for Safety Fire Test of Interior Finish Material; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.

C. Certificates: Certify that products of this section meet or exceed specified requirements.

D. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

E. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

F. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

1.06 MOCK-UPS

A. Locate where directed.

B. Mock-up may remain as part of work.

1.07 FIELD CONDITIONS

A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.

B. Do not apply foam when temperature is within 5 degrees F (2.78 degrees C) of dew point.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Foamed-In-Place Insulation:
   1. BASF Corporation; WALLTITE US Series Closed Cell: www.spf.basf.com/#sle.
   2. Henry, a Carlisle Company: www.henry.com/#sle.

2.02 MATERIALS

A. Foamed-In-Place Insulation: Medium-density, flexible, open cell or closed cell, water vapor permeable polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
   1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
      a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch (12.7 mm) gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
   2. Thermal Resistance: R-value (RSI-value) of 3.0 (0.53), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
   3. Air Permeance: 0.04 cfm per square foot (0.2 L/(s/sq m)), maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf (75 Pa).
   4. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
   5. Basis of Design:
      a. BASF Corporation; WALLTITE® Insulating Air Barrier: www.spf.basf.com/#sle.
      b. Henry Company; PERMAX 2.0X Closed-cell foam insulation: www.henry.com/#sle.

2.03 ACCESSORIES

A. Thermal Barrier Coating: Sprayed cellulose thermal barrier insulation: ASTM E 119.
   1. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide International Cellulose Corporation URE-K Thermal Barrier System or comparable product by one of the following:.
      a. NCFI
      b. Henry
      c. Gaco Western
   2. Surface- Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 5 or less.
      b. Smoke-Developed Index: 5 or less.
   3. Fire Propagation Characteristics: Passes Temperature Transmission Fire Test and Integrity Fire Test of NFPA 275 testing as part of an approved assembly.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify work within construction spaces or crevices is complete before insulation application.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation adhesion.

3.02 PREPARATION

A. Mask and protect adjacent surfaces from over spray or dusting.

B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

A. Apply insulation in accordance with manufacturer's instructions.

B. Apply insulation by spray method, to a uniform monolithic density without voids.

C. Patch damaged areas.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Field inspections and tests will be performed by an independent testing agency.

C. Coordination of ABAA Tests and Inspections:
   1. Provide testing and inspection required by ABAA QAP.
   2. Notify in ABAA writing of schedule for air barrier work. Allow adequate time for testing and inspection.
   3. Cooperate with ABAA testing agency.
   4. Allow access to air barrier work areas and staging.
   5. Do not cover air barrier work until tested, inspected, and accepted.

3.05 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION 072119

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SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, and other items indicated in Flashing Fabrications.

B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

A. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

B. ASTM B32 - Standard Specification for Solder Metal; 2020.

C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

D. ASTM D4479/D4479M - Standard Specification for Asphalt Roof Coatings - Asbestos-Free; 2007 (Reapproved 2024).

E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement; 2025.

F. CDA A4050 - Copper in Architecture - Handbook; Current Edition.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 26 gauge, .0187 inch (.48 mm) thick; smooth No. 4 - Brushed finish.

B. Termination Bars: Stainless steel with top sealant lip and 1/4-inch holes spaced at 8 inches center-to-center; compatible with membrane and adhesives.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; T2 Termination Bar: www.h-b.com/#sle.
      b. Mortar Net Solutions; Termination Bars: www.mortarnet.com/#sle.
      c. York Manufacturing, Inc; Termination Bar: www.yorkmfg.com/#sle.

2.02 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.

F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.03 FLASHING

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.04 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Underlayment: Polyethylene, 6 mil, 0.006 inch (0.15 mm) thick.

C. Slip Sheet: Rosin-sized sheathing paper.

D. Primer Type: Zinc chromate.

E. Protective Backing Paint: Zinc molybdate alkyd.

F. Concealed Sealants: Non-curing butyl sealant.

G. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

H. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

I. Reglets: Recessed type, stainless steel; face and ends covered with plastic tape.

J. Solder: ASTM B32, Alloy Grade - Sn50 (50/50).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.

C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.03 INSTALLATION

A. Unless otherwise indicated, install flashing and trim to comply with performance requirements, manufacturer's installation instructions, SMACNA (ASMM) and details shown. Anchor units of Work securely in place, providing for thermal expansion of metal units. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install exposed sheet metal Work 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 acceptable to the Owner's Representative. Install flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating flashing system.

C. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.

E. Capflashings: Coordinate installation of capflashings with installation of assemblies to be protected by capflashing. Install capflashings in joints provided in masonry, concrete, or stone, as applicable. Waterproof joint by means of elastomeric sealant. Lap capflashing joints a minimum of 2 inches (50 mm) and bed with sealant.

F. Welded Joints: Welded joints are to be used for stainless steel only. Clean surfaces to be welded, removing oils and foreign matter. Weld and grind joint smooth. Comply with applicable requirements of SMACNA (ASMM).

G. Sealed Joints: Unless otherwise shown, use mastic sealant when sealant will be completely concealed within the joint and elastomeric sealant when sealant will be exposed or used in an expansive joint condition. Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA (ASMM) standards. Fill joint with elastomeric sealant and form metal to completely conceal sealant. Use joint adhesive for nonmoving joints specified not to be soldered.

H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
   1. Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.
   2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.

I. Flashings in Masonry; General:
   1. Refer to standard masonry detail drawing(s) for additional requirements.
   2. Install embedded flashing in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
   3. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing.
   4. Place through-wall flashing on bed of mortar and cover with mortar. Seal penetrations in flashing with / adhesive / sealant / tape / metal cap soldered / in place as appropriate with the flashing material used before covering with mortar.
   5. Install flashing system as follows, unless otherwise shown on the Drawings:

a. At lintels and shelf angles, extend flashing full length of lintel or shelf angle to next masonry joint and exposed metal to opening width. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
b. At heads and sills, extend flashing system as specified above unless otherwise indicated but turn up ends not less than 2 inches to form an end dam.
c. Install flashing in masonry veneer walls as specified above but carry flashing up face of sheathing at least 8 inches and behind air, vapor or weather resistive barrier.
d. Interlock end joints of ribbed sheet metal flashings by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer and set overlap in mastic.
e. Preform sheet metal flashings at exterior face of masonry to form drip.
f. Cut off concealed flashing back 1/2 inch from face of wall.

J. Capflashings: Coordinate installation of capflashings with installation of assemblies to be protected by capflashing. Install capflashings in joints provided in masonry, concrete, or stone, as applicable. Waterproof joint by means of elastomeric sealant. Lap capflashing joints a minimum of 2 inches (50 mm) and bed with sealant.

K. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Weld or seal flashing to equipment support member.

L. Insert flashings into reglets to form tight fit; secure in place with lead wedges; seal flashings into reglets with sealant.

M. Secure flashings in place using concealed fastenersand set units true to line and level as indicated. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

N. Apply plastic cement compound between metal flashings and felt flashings.

O. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

P. Solder metal joints for full metal surface contact, and after soldering wash metal clean with neutralizing solution and rinse with water.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.05 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Clean and neutralize flux materials. Clean off excess solder

C. Clean off excess sealants.

D. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION 076200

SECTION 077200
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof curbs.

B. Equipment rails.

C. Roof penetrations mounting curbs.

D. Non-penetrating pedestals.

1.02 RELATED REQUIREMENTS

A. Section 077100 - Roof Specialties: Other manufactured roof specialty items.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used.
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Maintenance requirements.

C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 ROOF CURBS

A. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
   1. Roof Curb Mounting Substrate: Curb substrate consists of standing seam metal roof panel system.
   2. Sheet Metal Material:
      a. Aluminum: 0.080 inch (2.03 mm) minimum thickness, with 3003 alloy, and H14 temper.
   3. Fabricate curb bottom and mounting flanges for installation directly on metal roof panel system to match slope and configuration of system.

a. Extend side flange to next adjacent roof panel seam and comply with seam configurations and seal connection, providing at least 6 inch (152 mm) clearance between curb and metal roof panel flange allowing water to properly flow past curb.
b. Where side of curb aligns with metal roof panel flange, attach fasteners on upper slope of flange to curb connection allowing water to flow past below fasteners, and seal connection.
c. Maintain at least 12 inch (305 mm) clearance from curb, and lap upper curb flange on underside of down sloping metal roof panel, and seal connection.
d. Lap lower curb flange overtop of down sloping metal roof panel and seal connection.

4. Provide layouts and configurations indicated on drawings.

B. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of curb.
2. Insulate inside curbs with 1-1/2 inch (38 mm) thick fiberglass insulation.
3. Height Above Finished Roof Surface: 8 inches (203 mm), minimum.

C. Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.
1. Provide preservative treated wood nailers along top of rails.

D. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches (400 mm) square unless otherwise indicated.
1. Provide sliding channel welded along top edge with adjustable height steel bracket, fabricated to fit item supported.

2.02 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
1. Design Loadings and Configurations: As required by applicable codes.
2. Height: Provide minimum clearance of 6 inches (152 mm) under supported items to top of roofing.
3. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
5. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

B. Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and as indicated.

C. Duct Supports: Provide extruded aluminum supports and sized in accordance with diameter of supported ducts, and with base that is non-penetrating of roofing membrane.

D. Non-Penetrating Pedestals: Steel pedestals with square, round, or rectangular bases.
1. Bases: High density polypropylene.
2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

A. Clean installed work to like-new condition.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 077200

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SECTION 078400
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

A. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

C. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

D. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.

E. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2024.

F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus; 2025b.

G. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2024.

H. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a, with Editorial Revision (2024).

I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

J. FM (AG) - FM Approval Guide; Current Edition.

K. FM 4991 - Approval Standard of Firestop Contractors; 2013.

L. ITS (DIR) - Directory of Listed Products; Current Edition.

M. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

N. UL (DIR) - Online Certifications Directory; Current Edition.

O. UL (FRD) - Fire Resistance Directory; Current Edition.

P. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

Q. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

D. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.

E. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Installer Qualifications: Company specializing in performing the work of this section and:
1. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
2. Verification of minimum three years documented experience installing work of this type.
3. Verification of at least five satisfactorily completed projects of comparable size and type.
4. Licensed by local authorities having jurisdiction (AHJ).

1.06 MOCK-UPS

A. Install one firestopping assembly representative of each fire rating design required on project.
1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. If accepted, mock-up will represent minimum standard for this work.

C. If accepted, mock-up may remain as part of this work. Remove and replace mock-ups not accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Firestopping Manufacturers:
1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
2. Hilti, Inc: www.hilti.com/#sle.
3. RectorSeal, a CSW Industrials Company: www.rectorseal.com/firestop-solutions/#sle.
4. Specified Technologies Inc: www.stifirestop.com/#sle.

2.02 MATERIALS

A. Firestopping Materials: Any materials meeting requirements., unless specific material or system is indicated on the Drawings.

B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.

C. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.

D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

E. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
   1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
   2. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.

B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.

C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.
   2. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
   1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
   2. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

E. Acoustically Rated Firestopping: Provide system tested in accordance with ASTM E90 with STC rating of 50, minimum.

2.04 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements., unless specific material or system is indicated on the Drawings.
   1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

C. Do not cover installed firestopping until inspected by authorities having jurisdiction.

D. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

E. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

F. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

G. Provide and install any additional labeling as required by code.

3.04 FIELD QUALITY CONTROL

A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.

B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 078400

SECTION 079200
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Self-leveling pourable joint sealants.

C. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.

B. Section 079100 - Preformed Joint Seals: Precompressed foam, gaskets, and strip seals.

1.03 REFERENCE STANDARDS

A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).

B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).

C. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2024.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.

G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.

H. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.

I. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.

J. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.

K. ASTM C1382 - Standard Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints; 2016 (Reapproved 2023).

L. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2025).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, 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.

C. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

D. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.

E. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.

F. Executed warranty.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.

B. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
   1. Adhesion Testing: In accordance with ASTM C794.
   2. Compatibility Testing: In accordance with ASTM C1087.
   3. Allow sufficient time for testing to avoid delaying the work.
   4. Deliver sufficient samples to manufacturer for testing.
   5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.

C. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
   1. Identification of testing agency.
   2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
      a. Test date.
      b. Copy of test method documents.
      c. Age of sealant upon date of testing.
      d. Test results, modeled after the sample form in the test method document.
      e. Indicate use of photographic record of test.

D. Field Adhesion Test Procedures:
   1. Allow sealants to fully cure as recommended by manufacturer before testing.
   2. Have a copy of the test method document available during tests.
   3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
   4. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
   5. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
   6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

E. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.
   1. Sample: At least 18 inches (457 mm) long.
   2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch (25.4 mm) by that percentage; if adhesion failure occurs before the 1-inch mark is that distance from the substrate, the test has failed.
   3. If either adhesive or cohesive failure occurs before minimum elongation, take necessary measures to correct conditions and retest; record each modification to products or installation procedures.

F. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nonsag Sealants:
1. Bostik Inc: www.bostik-us.com/#sle.
2. Dow: www.dow.com/#sle.
3. Momentive Performance Materials, Inc: www.momentive.com/#sle.
4. Pecora Corporation: www.pecora.com/#sle.
5. Sika Corporation: usa.sika.com/#sle.
6. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

B. Self-Leveling Sealants:
1. Dow: www.dow.com/#sle.
2. Pecora Corporation: www.pecora.com/#sle.
3. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 JOINT SEALANT APPLICATIONS

A. Scope:
1. Exterior Joints:
   a. Seal the following joints:
      1) Wall expansion and control joints.
      2) Joints between doors, windows, and other frames or adjacent construction.
      3) Joints between different exposed materials.
2. Interior Joints:
   a. Do not seal interior joints indicated on drawings as not sealed.
   b. Do not seal gaps and openings in gypsum board and suspended ceilings
   c. Do not seal through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
   d. Seal the following joints:
      1) Joints between door frames and window frames and adjacent construction.
      2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
      3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
3. Do Not Seal:
   a. Intentional weep holes in masonry.
   b. Joints indicated to be covered with expansion joint cover assemblies.
   c. Joints where sealant installation is specified in other sections.

B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.

C. Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.

D. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.03 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 016116.

2.04 NONSAG JOINT SEALANTS

A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M, A, G, and O; not expected to withstand continuous water immersion or traffic.
   1. Movement Capability: Plus and minus ____ percent, minimum.
   2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
   3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.

2.05 SELF-LEVELING JOINT SEALANTS

A. Self-Leveling Silicone Sealant: ASTM C920, Grade P, Uses M and A; single or multicomponent, explicitly approved by manufacturer for traffic exposure when recessed below traffic surface; not expected to withstand continuous water immersion.
   1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.

2.06 ACCESSORIES

A. Sealant Backing Rod, Closed-Cell Type:
   1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
   2. Size: 25 to 50 percent larger in diameter than joint width.

B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.

E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
   1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
   2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
   3. Record each test on Preinstallation Adhesion Test Log as indicated.
   4. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
   5. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Provide joint sealant installations complying with ASTM C1193.

C. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
   1. Width/depth ratio of 2:1.
   2. Neck dimension no greater than 1/3 of the joint width.
   3. Surface bond area on each side not less than 75 percent of joint width.

D. Install bond breaker backing tape where backer rod cannot be used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.

C. Destructive Adhesion Testing: If there are any failures in first 1,000 linear feet (300 linear m), notify Architect immediately.

D. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

E. Repair destructive test location damage immediately after evaluation and recording of results.

3.05 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

END OF SECTION 079200

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SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated hollow metal doors and frames.

B. Fire-rated hollow metal doors and frames.

C. Thermally insulated hollow metal doors with frames.

1.02 RELATED REQUIREMENTS

A. Section 087100 - Door Hardware.

B. Section 088000 - Glazing: Glass for doors and borrowed lites.

C. Section 099123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

A. ANSI: American National Standards Institute.

B. ASCE: American Society of Civil Engineers.

C. HMMA: Hollow Metal Manufacturers Association.

D. NFPA: National Fire Protection Association.

E. SDI: Steel Door Institute.

F. UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2025.

C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2026.

D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.

E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.

F. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.

G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

J. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.

K. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

M. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.

N. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

O. ITS (DIR) - Directory of Listed Products; Current Edition.

P. NAAMM HMMA 805 - Recommended Selection and Usage Guide for Hollow Metal Doors and Frames; 2012.

Q. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.

R. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2024.

S. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.

T. NAAMM HMMA 850 - Fire-Rated Hollow Metal Doors and Frames; 2014.

U. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.

V. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

W. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.

X. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

Y. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.

Z. UL (DIR) - Online Certifications Directory; Current Edition.

AA. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

BB. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.

C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: https://steeldoor.org/sdi-certified/#sle.

B. Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hollow Metal Doors and Frames:

1. Ceco Door, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
2. Curries, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
3. Mesker, dormakaba Group; FDJ Series Drywall Frames: www.meskeropeningsgroup.com/#sle.
4. Republic Doors, an Allegion brand; ____: www.republicdoor.com/#sle.
5. Steelcraft, an Allegion brand; ____: www.allegion.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:
   1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.
   3. Door Edge Profile: Manufacturers standard for application indicated.
   4. Typical Door Face Sheets: Flush.
   5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
   6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
   7. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
      a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

A. Door Finish: Factory finished.

B. Exterior Doors: Thermally insulated.
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 2 - Seamless.
      d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
      e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
   2. Door Core Material: Polyurethane, 1.8 lbs/cu ft minimum density.
      a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
   3. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.

4. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
5. Top Closures for Outswinging Doors: Flush with top of faces and edges.
6. Weatherstripping: Refer to Section 087100.

C. Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
a. Level 2 - Heavy-duty.
b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
c. Model 2 - Seamless.
d. Door Face Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
2. Door Thickness: 1-3/4 inches (44.5 mm), nominal.

D. Fire-Rated Doors:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
a. Level 2 - Heavy-duty.
b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
c. Model 2 - Seamless.
d. Door Face Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
3. Temperature-Rise Rating (TRR) Across Door Thickness: In accordance with local building code and authorities having jurisdiction.
4. Provide units listed and labeled by UL (DIR) or ITS (DIR).
a. Attach fire rating label to each fire rated unit.
5. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following;
a. Maximum Air Leakage: 3.0 cfm/sq ft (0.02 cu m/sec/sq m) of door opening at 0.10 inch w.g. (24.9 Pa) pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
b. Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
c. Label: Include the "S" label on fire-rating label of door.
6. Door Thickness: 1-3/4 inches (44.5 mm), nominal.

2.04 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Exterior Door Frames: Knock-down type.
1. Basis of Design - Ceco Door, an Assa Abloy Group company Mercury Series TQB and TRB Thermal Break Frames
2. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
3. Frame Metal Thickness: 14 gauge, 0.067 inch (1.7 mm), minimum.
4. Frame Finish: Factory primed and field finished.
5. Threshold: Door and Frame manufacturer’s standard thermal break threshold.
a. Basis of Design: Pemko 273x3AFG.
6. Weatherstripping: Separate, see Section 087100.

C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
1. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.

2. Frame Finish: Factory primed and field finished.

D. Door Frames, Fire-Rated: Full profile/continuously welded type.
1. Fire Rating: Same as door, labeled.
2. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
3. Frame Finish: Factory primed and field finished.

E. Mullions for Pairs of Doors: Fixed, with profile similar to jambs.

F. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

G. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches (102 mm) high to fill opening without cutting masonry units.

H. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.

2.05 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

A. Glazing: As specified in Section 088000, factory installed.

B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

C. Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.

D. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.

E. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches (102 mm) as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.

H. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.

E. Masonry Partitions: Solidly pack mineral-fiber insulation inside frames.
   1. Where indicated on the Drawings, grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

F. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

G. Install door hardware as specified in Section 087100.
   1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.

H. Comply with glazing installation requirements of Section 088000.

I. Coordinate installation of electrical connections to electrical hardware items.

J. Touch up damaged factory finishes.

3.04 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.

B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

B. Adjust sound control doors so that seals are fully engaged when door is closed.

C. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.06 SCHEDULE

A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION 081113

SECTION 083100
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ceiling-mounted access units.

1.02 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Field paint finish.

1.03 REFERENCE STANDARDS

A. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

B. FM (AG) - FM Approval Guide; Current Edition.

C. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C. Shop Drawings: Indicate exact position of each access door and/or panel unit.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

A. Fire-Rated Ceiling-Mounted Units:
   1. Ceiling Fire-Rating: 1 hour.
   2. Size: 24 by 24 inches (___ by ___ mm).
   3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to proceeding with this work.

B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings, and secure units rigidly in place.

C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 083100

SECTION 083323
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire-rated coiling doors.

1.02 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ITS (DIR) - Directory of Listed Products; Current Edition.

C. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

D. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.

E. UL (DIR) - Online Certifications Directory; Current Edition.

F. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

G. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide general construction and component connections and details.

C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

D. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures, and _____.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

H. Specimen warranty.

1.04 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years documented experience.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for roller shaft counterbalance assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Fire Doors:
   1. Cornell Iron Works, Inc: www.cornelliron.com/#sle.
   2. Overhead Door Corporation: www.overheaddoor.com/#sle.

3. Raynor Garage Doors: www.raynor.com/#sle.
4. The Cookson Company: www.cooksondoor.com/#sle.

2.02 COILING DOORS

A. Fire-Rated Coiling Doors: Steel slat curtain; comply with NFPA 80.
   1. 3/4 hour fire rating.
      a. Provide smoke and draft control door assemblies tested in accordance with UL 1784.
   2. Provide products listed and labeled by ITS (DIR) or UL (DIR) as suitable for purpose specified and indicated on drawings.
   3. Oversized Openings: Provide certificate of compliance from authorities having jurisdiction indicating approval of fire rated units and operating hardware assembly.
   4. Sandwich Slats: Manufacturer's standard, with core of mineral wool insulation; minimum R-value of 4.88 (RSI-value of 0.86).
   5. Finish: Primed.
   6. Guides, Angles: Primed steel.
   7. Hood Enclosure: Manufacturer's standard; primed steel.
   8. Coiling Door Release Mechanism: Fusible link activated with automatically governed closing speed.
   9. Manual hand chain lift operation.
   10. Mounting: Surface mounted.
   11. Locking Devices: Lock and latch handle on outside.

2.03 MATERIALS

A. Metal Curtain Construction: Interlocking slats.
   1. Curtain Bottom for Slat Curtains: Fitted with angles to provide reinforcement and positive contact in closed position.
   2. Weatherstripping for Exterior Doors: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
   3. Smoke Seals: Provide brush or gasket type weatherstripping seals to prevent passage of smoke and hot gases in compliance with UL 1784 testing requirements.

B. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

C. Guides - Angle: ASTM A36/A36M metal angles, size as indicated.
   1. Prime painted.

D. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.

E. Lock Hardware:
   1. Latch Handle: Manufacturer's standard.
   2. Manual Chain Lift: Provide padlockable chain keeper on guide.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that adjacent construction is suitable for door installation.

B. Verify that electrical services have been installed and are accessible.

C. Verify that door opening is plumb, header is level, and dimensions are correct.

D. Notify Architect of any unacceptable conditions or varying dimensions.

E. Commencement of installation indicates acceptance of substrate and door opening conditions.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install fire-rated doors in accordance with NFPA 80.

C. Install smoke door assemblies in accordance with NFPA 105.

D. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

E. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

F. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

G. Install enclosure and perimeter trim.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch (1.6 mm).

C. Maximum Variation From Level: 1/16 inch (1.6 mm).

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet (3.2 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION 083323

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SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Infill panels of glass.

C. Aluminum doors and frames.

1.02 REFERENCE STANDARDS

A. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2024.

B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2026.

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

D. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.

E. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

F. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

G. FLA (PAD) - Florida Building Code Online - Product Approval Directory; Current Edition.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.06 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum-Framed Storefronts:
   1. Kawneer North America: www.kawneer.com/#sle.
   2. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
   3. Tubelite, Inc: www.tubeliteinc.com/#sle.

B. Entrance Doors:

2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

A. Center-Set Style, Thermally-Broken:
   1. Basis of Design: Kawneer 451 T.
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (51 mm wide by 114 mm deep).

2.03 BASIS OF DESIGN -- FRAMING FOR MONOLITHIC GLAZING

A. Center-Set Style, Wind-Borne-Debris Resistance Tested:
   1. Basis of Design: Kawneer 450.
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (51 mm wide by 114 mm deep).

2.04 BASIS OF DESIGN -- SWINGING DOORS

A. Wide Stile, Monolithic Glazing:
   1. Basis of Design: Kawneer 500.
   2. Thickness: 1-3/4 inches (43 mm).

B. Wide Stile, Insulating Glazing, Thermally-Broken:
   1. Basis of Design: Kawneer 500T.
   2. Thickness: 1-3/4 inches (43 mm).

2.05 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Finish: Superior performing organic coatings.
      a. Factory finish all surfaces that will be exposed in completed assemblies.
      b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
   2. Finish Color: Match existing aluminum framing.
   3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
   a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, having Florida Building Code FLA (PAD) approval for Large and Small Missile impact and pressure cycling at design wind pressure.
3. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.

2.06 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.

2.07 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.08 FINISHES

A. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF), multi-coat, superior-performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin or powder, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch (0.030 mm).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Set thresholds in bed of sealant and secure.

J. Install glass and infill panels using glazing method required to achieve performance criteria; see Section 088000.

K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet (1.5 mm per m) non-cumulative or 0.06 inch per 10 feet (1.5 mm per 3 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 FIELD QUALITY CONTROL

A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.

B. See Section 014000 - Quality Requirements for independent field testing and inspection requirements, and requirements for monitoring quality of specified product installations.

C. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
   1. Perform a minimum of two tests in each designated area as indicated on drawings.
   2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
   3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf (200 Pa).
      a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce (14 gram) that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.

D. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084313

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SECTION 084435
FIRE-RATED FRAMED GLAZED ASSEMBLIES - SAFTI

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire-resistive-rated framing.

B. Fire-resistive-rated, temperature-rise doors.

C. Fire-resistive-rated glazing.

1.02 REFERENCE STANDARDS

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

B. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2026.

C. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).

D. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

F. ASTM C1036 - Standard Specification for Flat Glass; 2025.

G. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.

H. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2024.

I. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

J. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.

K. ITS (DIR) - Directory of Listed Products; Current Edition.

L. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

M. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

N. NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies; 2022.

O. UL (DIR) - Online Certifications Directory; Current Edition.

P. UL 9 - Standard for Fire Tests of Window Assemblies; Current Edition, Including All Revisions.

Q. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

R. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

S. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

T. UL 752 - Standard for Bullet-Resisting Equipment; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer’s published product data on framing, glazing, anchorage, fasteners, doors, and hardware. Show compliance with fire performance and other criteria.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

D. Executed warranty.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of professional structural engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Provide glass products listed and manufactured under follow-up program of inspections conducted by ITS (DIR) or UL (DIR).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.06 WARRANTY

A. Manufacturer Warranty: Provide 5-year manufacturer warranty from date of shipping against product defects . Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. SAFTI FIRST, a division of O'Keeffe's Inc: www.safti.com/#sle.

B. TGP Fire Frames.

C. Furnish framing, glazing, and doors from single manufacturer and obtained from a single supppllier.

D. Provide glazed assembly manufacturer's recommended door hardware by approved hardware manufacturers.

2.02 FIRE-RATED ASSEMBLIES

A. Type FRRD-1 - Fire-Resistance-Rated, Temperature Rise Door:
   1. Application: At openings indicated on drawings.
   2. Rating: As indicated on drawings.
   3. Framing: GPX Architectural Series Fire Resistive Framing.
   4. Doors: GPX Builders Series Temperature Rise Doors.
   5. Vision Light Glazing: 60-minute fire-resistive tempered units; SuperLite II-XL 60.
      a. Provide fire-rated insulating glass units (IGUs).
      b. Employ low-iron glass in glazing units.
      c. Incorporate inoplast interlayer into glass units to provide required hurricane resistance.
   6. Door Hardware: Provide assembly manufacturer's recommended hardware to suit application.

2.03 PERFORMANCE REQUIREMENTS

A. Provide factory-fabricated, factory-finished framing members with glazing and related anchorage and attachment devices.

B. Fire Performance Certification: Listed by UL (DIR) or ITS (DIR).

C. Fire-Resistive Wall Assemblies: Provide hourly fire ratings as indicated in contract documents, tested as assembly including glazing complying with ASTM E119 or UL 263 and requirements of authorities having jurisdiction.

D. Fire-Resistive, Temperature Rise Doors: Provide hourly fire ratings as indicated in contract documents; tested as assembly including glazing and framing complying with NFPA 252, UL 10B, and UL 10C and requirements of authorities having jurisdiction. Not more than 250 degrees F (121 degrees C) temperature rise on unexposed face.

E. Impact Resistance of Glazing in Hazardous Locations: Comply with ANSI Z97.1 - Class A and 16 CFR 1201 - Category II impact test requirements.

F. Structural Performance: Design and size components to withstand imposed loads without damage or permanent set.
   1. Design Loads: 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.
   3. Provide glass edge support system sufficiently stiff to limit lateral deflection of supported glass edges to less than 1/175 of length or 3/4 inch (19 mm), whichever is less, under specified design load.

2.04 MATERIALS

A. Aluminum Sheet: ASTM B209/B209M.

B. Internal Framing: ASTM A501/A501M, with galvanized cladding retainers.

C. Float Glass:
   1. Annealed: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
   2. Tempered: Comply with ASTM C1048, Kind FT.
   3. Impact-Resistant Safety Glass: Comply with ANSI Z97.1 - Class A and 16 CFR 1201 - Category II.

D. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
   1. Laminated Safety Glass: Comply with ANSI Z97.1 - Class A and 16 CFR 1201 - Category II impact test requirements.
   2. Ionoplast interlayer.

E. Structural Silicone Sealant for Hurricane Assembly: In accordance with hurricane listing of authorities having jurisdiction.

2.05 FINISHES

A. Finishing: Apply factory finish to surfaces that will be exposed in completed assemblies.
   1. Touch up surfaces cut during fabrication so no natural metal surfaces are visible in completed assemblies, including joint edges.

B. Apply factory finish to surfaces that will be exposed in completed assemblies.

C. Color: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and attachment method with other work.

B. Verify wall openings and adjoining water-resistive barrier materials are ready to receive work of this section.

C. Verify anchorage devices are correctly installed and located.

3.02 INSTALLATION

A. Install wall system in accordance with limitations of fire rating and with manufacturer's instructions.

B. Attach to structure to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form watertight dam.

G. Touch up minor damage to factory-applied finish; replace components that cannot be repaired to as-new condition.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 1/16 inch per 3 feet (1.6 mm per 0.914 m) noncumulative or 1/2 inch per 100 feet (12.7 mm per 30.5 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting In-Plane: 1/32 inch (0.8 mm).

C. Sealant Space between Mullions and Adjacent Construction: Maximum of 3/4 inch (19 mm) and minimum of 1/4 inch (6.4 mm).

3.04 ADJUSTING

A. Adjust doors for smooth operation.

3.05 CLEANING

A. Remove protective material from prefinished surfaces.

B. Wash down surfaces with solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.06 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084435

SECTION 092116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal channel ceiling framing.

C. Acoustic insulation.

D. Gypsum sheathing.

E. Cementitious backing board.

F. Gypsum wallboard.

G. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

C. Section 078400 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.

D. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

E. Section 092216 - Non-Structural Metal Framing.

1.03 REFERENCE STANDARDS

A. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.

B. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2023.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

D. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2025.

H. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.

I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

K. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2024.

L. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units; 2025.

M. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.

N. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2024.

O. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019 (Reapproved 2024).

P. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

R. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

S. ASTM E413 - Classification for Rating Sound Insulation; 2022.

T. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.

U. GA-600 - Fire Resistance and Sound Control Design Manual; 2024.

V. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Install service utilities in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft (0.24 kPa) with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

D. Fire-Resistance-Rated Assemblies: Provide completed assemblies with the following characteristics:

2.02 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. American Gypsum Company; ____: www.americangypsum.com/#sle.
   2. CertainTeed Corporation; ____: www.certainteed.com/#sle.
   3. Georgia-Pacific Gypsum; ____: www.gpgypsum.com/#sle.
   4. Gold Bond Building Products, LLC provided by National Gypsum Company; ____: www.goldbondbuilding.com/#sle.
   5. USG Corporation; ____: www.usg.com/#sle.

B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
   3. Thickness:
      a. Vertical Surfaces: 5/8 inch (16 mm).
      b. Ceilings: 5/8 inch (16 mm).

C. Abuse Resistant Wallboard:
   1. Application: High-traffic areas indicated.
   2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
   4. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   5. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   6. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
   7. Type: Fire-resistance-rated Type X, UL or WH listed.
   8. Thickness: 5/8 inch (16 mm).
   9. Edges: Tapered.
   10. Paper-Faced Products:
      a. American Gypsum Company; M-Bloc AR Type X: www.americangypsum.com/#sle.
      b. CertainTeed Corporation; Extreme Abuse Resistant Drywall with M2Tech: www.certainteed.com/#sle.
      c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Hi-Abuse Gypsum Board: www.goldbondbuilding.com/#sle.
      d. USG Corporation; Fiberock Brand Aqua-Tough AR Interior Panels Regular 1/2 in. (12.7 mm): www.usg.com/#sle.

D. Impact Resistant Wallboard:
   1. Application: High-traffic areas indicated.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Type: Fire-resistance-rated Type X, UL or WH listed.
   4. Thickness: 5/8 inch (16 mm).
   5. Edges: Tapered.

E. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 1/2 inch (13 mm).

3. Edges: Tapered.

F. Shaftwall and Coreboard: Type X; 1 inch (25 mm) thick by 24 inches (600 mm) wide, beveled long edges, ends square cut.
   1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Paper-Faced Products:
      a. American Gypsum Company; M-Bloc Shaft Liner: www.americangypsum.com/#sle.
      b. CertainTeed Corporation; M2Tech Type X Shaftliner: www.certainteed.com/#sle.
      c. Georgia-Pacific Gypsum; ToughRock Shaftliner: www.gpgypsum.com/#sle.
      d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Shaftliner XP: www.goldbondbuilding.com/#sle.
      e. USG Corporation; Sheetrock Brand Gypsum Liner Panels 1 in. (25.4 mm) SLX: www.usg.com/#sle.

2.03 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches (50.8 mm).

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

C. Finishing Accessories:
   1. Types: As detailed or required for finished appearance.
   2. Materials: 6063-T5 extruded aluminum alloy and G40 (Z120) galvanized steel sheet in accordance with ASTM A653/A653M.

D. Finishing Compound: Surface coat and primer, takes the place of skim coating.

E. High Build Drywall Surfacer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.

F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
   1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches (600 mm) on center.
   2. Install studs at spacing required to meet performance requirements.

B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.
   1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
   2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.03 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.

D. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated on drawings.
   1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.07 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
   2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   4. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
   2. Taping, filling, and sanding are not required at base layer of double-layer applications.

E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.08 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

END OF SECTION 092116

SECTION 092216
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal partition, ceiling, and soffit framing.

B. Backing reinforcment in walls

C. Grid suspension system for gypsum board ceilings.

D. Framing accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping: Sealing top-of-wall assemblies at fire-resistance-rated walls.

B. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

C. Section 092116 - Gypsum Board Assemblies: Metal studs for gypsum board partition framing.

1.03 REFERENCE STANDARDS

A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.

B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

D. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2025.

E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.

F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

G. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

H. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections; 2024.

I. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

J. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

K. ASTM E413 - Classification for Rating Sound Insulation; 2022.

L. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

M. GA-600 - Fire Resistance and Sound Control Design Manual; 2024.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

D. SSMA Manufacturer Qualification: Submit documentation of manufacturer association membership.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Framing, Connectors, and Accessories:
   1. CEMCO: www.cemcosteel.com/#sle.
   2. ClarkDietrich: www.clarkdietrich.com/#sle.
   3. Jaimes Industries: www.jaimesind.com/#sle.
   4. MarinoWARE: www.marinoware.com/#sle.
   5. SCAFCO Corporation: www.scafco.com/#sle.
   6. Simpson Strong Tie: www.strongtie.com/#sle.
   7. Steel Construction Systems: www.steelconsystems.com/#sle.
   8. The Steel Network, Inc: www.SteelNetwork.com/#sle.
   9. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING MATERIALS

A. Fire-Resistance-Rated Assemblies: Comply with applicable code and as follows:
   1. Provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

B. Firestopping: Materials meeting requirements necessary to maintain rating of penetrated assembly.

C. Material and Product Requirements: AISI S201 and AISI S220.

D. Nonstructural Framing System Components: Sheet steel, of size and properties necessary for spacing indicated on drawings, with maximum wall framing deflection of L/240 at 5 psf (240 Pa).
   1. Studs: C-shaped.
      a. Minimum Base-Metal Thickness: Unless otherwise indicated on the drawings, 0.0329 inch (0.836 mm) [20 gauge].
         1) Equivalent Gauge (EQ) studs are not acceptable unless they are the stated minimum base-metal thickness specified.
   2. Runners: U-shaped, sized to match studs. Unless otherwise indicated on the drawings, 0.0329 inch (0.836 mm) [20 gauge].
   3. Ceiling Channels: U-shaped.
      a. Minimum Base-Metal Thickness: Unless otherwise indicated on the drawings, 0.0329 inch (0.836 mm) [20 gauge].
   4. Furring: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).
   5. Furring: Z-shaped sections, minimum depth of 1-1/4 inch (32 mm).
      a. Thickness: 20 gauge, 0.0359 inch (0.91 mm).
   6. Resilient Furring Channels: Double leg configuration; 1/2 inch (12 mm) channel depth unless otherwise indicated on the Drawings.

E. Shaft Wall Studs and Accessories: Galvanized sheet steel.

F. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and braced with continuous bridging on both sides.

G. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.

H. Preformed Top Track Firestop Seal:
   1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
   2. Products:
      a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com/#sle.
      b. Specified Technologies Inc; SpeedFlex TTG Track Top Gasket: www.stfirestop.com/#sle.

I. Nonstructural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
      a. Material: ASTM A653/A653M steel sheet with factory-welded steel plate base.
         1) Height: 34 inches (864 mm).
   3. Bracing and Bridging: ASTM A653/A653M, G90 (Z275) galvanized steel; for lateral bracing of wall studs with slots for engaging on-module studs.
   4. Gusset Plates: ASTM A653/A653M, G90 (Z275) galvanized steel; for reinforcing framing members modified or field cut with oversized openings on web of member.
   5. Framing Connectors: ASTM A653/A653M steel clips; secures cold rolled channel to wall studs for lateral bracing.
   6. Sheet Metal Backing: 16 gauge, 0.0598 inch (1.52 mm) thick.
   7. Fasteners: ASTM C1513 self-piercing, self-tapping screws.
   8. Anchorage Devices: Powder actuated.
   9. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness as required for STC.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that rough-in utilities are in proper location.

3.02 INSTALLATION OF STUD FRAMING

A. Install non-structural members in accordance with ASTM C754.

B. Extend partition framing to structure where indicated and to ceiling in other locations.

C. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

D. Fire-Resistance-Rated Construction: Install framing and accessories in accordance with requirements of fire-resistance-rated assembly and to GA-600 requirements.

E. Align and secure top and bottom runners at 24 inches (600 mm) on center.

F. At partitions indicated with an acoustic rating:
   1. Provide components and install as required to produce STC ratings as indicated, based on published tests by manufacturer conducted in accordance with ASTM E90 with STC rating calculated in accordance with ASTM E413.
   2. Place one bead of acoustic sealant between runners and substrate , studs and adjacent construction.
   3. Place one bead of acoustic sealant between studs and adjacent vertical surfaces.

G. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

H. Install studs vertically at spacing indicated on drawings.

I. Align stud web openings horizontally.

J. Secure studs to tracks using crimping method. Do not weld.

K. Stud splicing is not permissible.

L. Fabricate corners using a minimum of three studs.

M. Install double studs at wall openings, door and window jambs, not more than 2 inches (50 mm) from each side of openings.

N. Coordinate erection of studs with requirements of door frames; install supports and attachments.

O. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

P. Blocking: Use wood blocking secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and opening frames.

Q. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches (150 mm).

R. Use sheet metal backing for reinforcement where indicated on the Drawings.

3.03 CEILING AND SOFFIT FRAMING

A. Comply with requirements of ASTM C754.

B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

C. Install furring independent of walls, columns, and above-ceiling work.

D. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.

E. Space main carrying channels at maximum 72 inches (1 800 mm) on center, and not more than 6 inches (150 mm) from wall surfaces. Lap splice securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches (50 mm) from perimeter walls, and rigidly secure. Lap splices securely.

H. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches (600 mm) past each opening.

I. Laterally brace suspension system.

3.04 TOLERANCES

A. Maximum Variation From True Position: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation From Plumb: 1/8 inch in 10 feet (3 mm in 3 m).

END OF SECTION 092216

SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Division 21 Section: Sprinkler heads in ceiling system.

C. Division 23 Section: Air diffusion devices in ceiling.

D. Division 26 Section: Light fixtures in ceiling system.

E. Division 28 Section: Fire alarm components in ceiling system.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.

C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019 (Reapproved 2025).

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

F. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2024a.

G. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on suspension system components and acoustical units.

C. Samples: Submit two samples 6 by 6 inch (150 by 150 mm) in size illustrating material and finish of acoustical units.

D. Samples: Submit two samples each, 6 inches (150 mm) long, of suspension system main runner, cross runner, and perimeter molding.

E. Manufacturer's qualification statement.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.

2. Extra Acoustical Units:Quantity equal to 5 percent of total installed of each exposed component.
3. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.06 QUALITY ASSURANCE

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

B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

B. During and after installation, maintain ambient temperature and humidity conditions at the levels indicated for Project when occupied for its intended use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustic Tiles/Panels:
1. Peovide the manufacturers indicated in the "Finish Materials List" on the Drawings.

B. Suspension Systems:
1. Provide the manufacturers indicated in the "Finish Materials List" on the Drawings.

2.02 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Class A in accordance with ASTM E84.testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Flame-Spread Index: Class A according to ASTM E1264.

C. Smoke-Developed Index: 450 or less.

2.03 ACOUSTICAL UNITS

A. Acoustical Units - General: ASTM E1264, Class A.
1. VOC Content: As specified in Section 016116.

2.04 SUSPENSION SYSTEMS

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold-down clips, stabilizer bars, clips, and splices as required.
1. Materials:
a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.

2.05 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.

C. Perimeter Moldings: Same metal and finish as grid.

D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Install after major above-ceiling work is complete.

B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions, as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Locate system on room axis according to reflected plan.

D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Install in bed of acoustical sealant.
   2. Use longest practical lengths.
   3. Overlap and rivet corners.

E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Lay directional patterned units as indicate on the drawings.

D. Fit border trim neatly against abutting surfaces.

E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Double cut and field paint exposed reveal edges.

G. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

H. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Clean surfaces.

C. Replace damaged or abraded components.

END OF SECTION 095100

SECTION 096700
FLUID-APPLIED FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fluid-applied flooring and base.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 079200 - Joint Sealants: Sealing joints between fluid-applied flooring and adjacent construction and fixtures.

1.03 REFERENCE STANDARDS

A. ANSI/ESD STM7.1 - Standard Test Method for the Protection of Electrostatic Discharge Susceptible Items Flooring Systems Resistive Characterization; 2020.

B. ASTM D905 - Standard Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading; 2008 (Reapproved 2021).

C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

D. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

E. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns and colors available.

C. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and application rate for each coat.

D. Maintenance Data: Include maintenance procedures, recommended maintenance materials, procedures for stain removal, repairing surface, and suggested schedule for cleaning.

1.05 QUALITY ASSURANCE

1.06 MOCK-UPS

A. Construct mock-up(s) of fluid applied flooring to serve as basis for evaluation of texture and workmanship.
   1. Number of Mock-Ups to be Prepared: One.
   2. Use same materials and methods for use in the work.
   3. Locate where directed.
   4. Minimum Size: 48 inches by 48 inches (1220 mm by 1220 mm).

B. Approved mock-up may remain as part of the work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store resin materials in a dry, secure area.

B. Store materials for three days prior to installation in area of installation to achieve temperature stability.

1.08 FIELD CONDITIONS

A. Maintain minimum temperature in storage area of 55 degrees F (13 degrees C).

B. Store materials in area of installation for minimum period of 24 hours prior to installation.

C. Maintain ambient temperature required by manufacturer 72 hours prior to, during, and 24 hours after installation of materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fluid-Applied Flooring:
   1. HooverWells; Rez-Stone;https://content.hooverwells.com/

2.02 FLUID-APPLIED FLOORING SYSTEMS

A. Fluid-Applied Flooring: Epoxy base coat(s), polyurethane top coat, no aggregate.
   1. System Thickness: 40 mils (1 mm), nominal, dry film thickness (DFT).
   2. Texture: Smooth.
   3. Sheen: Matte.
   4. Color: Match adjacent existing epoxy flooring.
   5. Basis of Design HooverWells; Rez

2.03 ACCESSORIES

A. Base Caps: Zinc with projecting base of 1/8 inch (3 mm); color as selected.

B. Subfloor Filler: Type recommended by fluid-applied flooring manufacturer.

C. Primer: Type recommended by fluid-applied flooring manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive flooring.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive flooring.

C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of materials to subfloor surfaces.

D. Verify that wood subfloors have 12 percent maximum moisture content.

E. Cementitious Subfloor Surfaces: Verify that substrates are ready for fluid-applied flooring installation by testing for moisture and alkalinity (pH).
   1. Obtain instructions if test results are not within limits recommended by fluid-applied flooring manufacturer.

3.02 PREPARATION

A. Prepare concrete surfaces according to ICRI 310.2R, _____.

B. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Grind irregularities above the surface level. Prohibit traffic until filler is cured.

C. Vacuum clean substrate.

D. Apply primer to surfaces required by flooring manufacturer.

3.03 INSTALLATION - ACCESSORIES

A. Install fillet strips at base of walls where flooring is to be extended up wall as base.

B. Install terminating cap strip at top of base; attach securely to wall substrate.

3.04 INSTALLATION - FLOORING

A. Apply in accordance with manufacturer's instructions.

B. Apply each coat to minimum thickness required by manufacturer.

C. Finish to smooth level surface.

D. Install flooring in recessed type floor access covers.

E. Cove at vertical surfaces.

3.05 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Test installed floor surface in accordance with ANSI/ESD STM7.1 .

3.06 PROTECTION

A. Prohibit traffic on floor finish for 48 hours after installation.

B. Barricade area to protect flooring until fully cured.

END OF SECTION 096700

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SECTION 099123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
   5. Floors, unless specifically indicated.
   6. Glass.
   7. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 055000 - Metal Fabrications: Shop-primed items.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

C. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

D. SSPC-SP 2 - Hand Tool Cleaning; 2024.

E. SSPC-SP 3 - Power Tool Cleaning; 2024.

F. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
   2. MPI product number (e.g., MPI #47).
   3. Cross-reference to specified paint system products to be used in project; include description of each system.

C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Paint and Finish Materials: 1 gal (4 L) of each color; from the same product run, store where directed.
   3. Label each container with color in addition to the manufacturer's label.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Provide lighting level of 80 fc (860 lux) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

B. Paints:
   1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
   2. Glidden Pro: www.glidden.com
   3. Benjamin Moore & Co: www.benjaminmoore.com
   4. PPG Paints: www.ppgpaints.com/#sle.

C. Primer Sealers: Same manufacturer as top coats.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
   1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. Supply each paint material in quantity required to complete entire project's work from a single production run.
   3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:
   1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
      a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

2.03 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
1. Gypsum Wallboard: 12 percent.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Masonry:
1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
2. Prepare surface as recommended by top coat manufacturer.
3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi (4,140 to 10,350 kPa) at 6 to 12 inches (150 to 300 mm). Allow to dry.

G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

H. Galvanized Surfaces:
1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
2. Prepare surface according to SSPC-SP 2.

I. Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.
2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection.

B. Owner will provide field inspection.

3.05 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099123

SECTION 104400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

C. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

B. FM (AG) - FM Approval Guide; Current Edition.

C. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

D. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide extinguisher operational features.

C. Shop Drawings: Indicate locations of cabinets, cabinet physical dimensions, and rough-in measurements for recessed cabinets.

D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:
   1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
   2. Larsen's Manufacturing Co; MP Series: www.larsensmfg.com/#sle.
   3. Nystrom, Inc: www.nystrom.com/#sle.

B. Fire Extinguisher Cabinets and Accessories:
   1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series: www.activarcpg.com/#sle.
   2. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
   3. Nystrom, Inc: www.nystrom.com/#sle.

2.02 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   1. Cartridge Operated: Spun shell.
   2. Class: A:B:C type.
   3. Size: 5 pound (2.27 kg).
   4. Finish: Baked polyester powder coat, gloss red color.

2.03 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.

B. Cabinet Construction: Non-fire rated.
   1. Formed primed steel sheet; 0.036 inch (0.9 mm) thick base metal.

C. Fire Rated Cabinet Construction: One-hour fire rated.
   1. Steel; double wall or outer and inner boxes with 5/8 inch (15.9 mm) thick fire barrier material.

D. Cabinet Configuration: Recessed type.
   1. Inside nominal dimensions of 9-1/2 inch (241 mm) wide by 24 inch (610 mm) high by 6 inch (152 mm) deep.
   2. Trim: Flat square edge, with 5/16 inch (8 mm) wide face.
   3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.

E. Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.

F. Door Glazing: Tempered glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.

G. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

H. Fabrication: Weld, fill, and grind components smooth.

I. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.

J. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.

B. Lettering: FIRE EXTINGUISHER decal, or vinyl self-adhering, pre-spaced black lettering in accordance with authorities having jurisdiction (AHJ).
   1. Factory applied die-cut lettering; vertical configuration applied to metal section of door.
      a. Color: White.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, 48 inches (1219 mm) from finished floor to centerline of door pull..

C. Secure rigidly in place.

D. Place extinguishers in cabinets.

3.03 MAINTENANCE

END OF SECTION 104400

SECTION 115300
LABORATORY EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Contractor-furnished laboratory equipment.

B. Installation of Contractor-furnished (CFCI) equipment.

C. Installation of Owner-furnished (OFCI) equipment.

D. Coordination with Owner-furnished Owner-installed (OFOI) equipment.

1.02 ABBREVIATIONS AND ACRONYMS

A. OFOI - Owner Furnishes and Owner Installs.

B. CFOI - Contractor Furnishes and Owner Installs.

C. OFCI - Owner Furnishes and Contractor Installs.

D. CFCI - Contractor Furnishes and Contractor Installs.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of laboratory equipment with laboratory casework and Owner-furnished, Owner-installed laboratory equipment.

B. Preinstallation Meeting: Convene one week before starting work of this section.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

D. See Equipment schedule on the drawings. The contractor, sub contracors and vendors will note that the equipment listed on the spreadsheet is by owner, and is subject to change. The contract will validate and coordinate final placement of and connections to, all equipment.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Equipment: Scheduled on drawings.

B. Owner furnishes and installs equipment noted as OFOI.

C. Owner furnishes and Contractor installs equipment noted as OFCI.

D. Contractor furnishes and installs equipment noted as CFCI.

E. Contractor furnishes and Owner installs equipment noted as CFOI.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that utility connections, rough-in frames, anchors and supports are accurately placed and deliver building services at specified characteristics and/or within acceptable functional ranges.

B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.02 INSTALLATION

A. Installation of equipment noted as OFOI or CFOI is by Owner. Coordinate those installations with work by Contractor.

B. Installation of equipment noted as OFCI or CFCI is by Contractor. Coordinate with equipment furnished and/or installed by Owner.

C. Install in accordance with manufacturer's instructions.

D. Install in accordance with standards required by authority having jurisdiction.

E. Large Components: Ensure that large components can be moved into final position without damage to other construction.

F. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner, and their locations are coordinated with equipment rough-in requirements.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Perform functional testing in accordance with referenced specification requirements. Test one item or similar model, as necessary or appropriate, to ensure that it is operational and installation complies with specification requirements.

3.04 ADJUSTING

A. Adjust operating equipment to efficient operation.

END OF SECTION 115300

SECTION 115313
LABORATORY FUME HOODS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Standard laboratory fume hoods.

B. Fume hood base cabinets and stands.

C. Work surfaces.

D. Laboratory cup sinks in fume hoods.

E. Service fittings and outlets.

F. Airflow indicators and alarms.

G. Piping within fume hoods for service fittings.

H. Wiring within fume hoods for light fixtures and receptacles.

1.02 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Blocking and nailers for anchoring fume hoods.

B. Section 092116 - Gypsum Board Assemblies: Reinforcements in metal-framed partitions for anchoring fume hoods.

C. Section 092216 - Non-Structural Metal Framing: Reinforcements in metal-framed partitions for anchoring fume hoods.

D. Section 096500 - Resilient Flooring: Resilient base applied to base cabinets.

E. Section 123553.13 - Metal Laboratory Casework: Additional requirements for base cabinets for fume hoods.

F. Section 230593 - Testing, Adjusting, and Balancing for HVAC: Field quality-control testing of fume hoods.

1.03 REFERENCE STANDARDS

A. ANSI Z9.5 - Laboratory Ventilation; 2022.

B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016, with Errata.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

F. SEFA 1 - Laboratory Fume Hoods; 2010.

G. UL 1805 - Standard for Safety Laboratory Fume Hoods and Cabinets; 2006.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of fume hoods with laboratory casework and other laboratory equipment.

B. Preinstallation Meeting: Conduct preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide fume hood exterior and interior dimensions and construction, utility and service requirements and locations.

C. Shop Drawings: Indicate locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, clearances required, locations and types of service fittings.

D. Samples: Submit two samples of exterior, interior, and work top finish surfaces, 4" X 4" inch (____by____ mm) in size illustrating color and finish.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Provide documentation of successful Factory Acceptance Testing.

F. Test Reports: Indicate that each type of fume hood has been factory-tested and meets specified ASHRAE Std 110 (AM) requirements.

G. Operation Data: Include description of equipment operation and required adjusting and testing.

H. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual locations of concealed utility connections.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.

C. Preconstruction Testing: Factory-test each type of hood as per referenced standard.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 FIELD CONDITIONS

A. Ambient Conditions: Maintain temperature and relative humidity at occupancy levels during and after installation of fume hoods.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Laboratory Fume Hoods:
   1. Bicasa USA Basis of Design.
   2. Waldner www.wna
   3. Kewaunee Scientific Corp;[____]: www.kewaunee.com/#sle.

B. Provide laboratory fume hoods from single manufacturer.

C. Provide laboratory fume hoods from same manufacturer as laboratory casework.

2.02 VARIABLE AIR VOLUME (VAV) FUME HOODS

A. Restricted-Bypass Fume Hoods:
   1. Provide a compensating bypass arrangement above the sash to open after sash is closed to less than 20 percent open. Bypass to maintain exhaust capacity of at least 25 CFM per square foot (127 L/s per square meter) of work surface regardless of sash position.
   2. Provide an electronic control unit designed to use input from a sensor that monitors face velocity or sash position to modulate a dedicated exhaust damper in order to maintain a near-constant fume hood face velocity.
      a. Provide control unit with outputs for interfacing with building's HVAC control system.

2.03 PERFORMANCE REQUIREMENTS

A. Fume hoods complying with the following when tested in accordance with ASHRAE Std 110:
   1. As-Manufactured (AM) Rating: AM 0.01 (0.01 ppm).
   2. As-Installed (AI) Rating: AI 0.10 (0.10 ppm).
   3. Average Face Velocity: 80 FPM plus or minus 10 percent with sashes fully open.
   4. Face-Velocity Variation: Not more than 10 percent of average face velocity across the face opening with sash(es) fully open.
      a. Test hoods with combination sashes fully raised, with maximum opening on one side, with maximum opening in the center, and with one opening at each side equal to half of maximum opening.
   5. Release Rate: 4.0 L/min.
   6. Static-Pressure Loss: Not more than 1/2-inch w.g. (124 Pa) at 80 FPM face velocity with sash fully open when measured at four locations 90 degrees apart around the exhaust duct and at least three duct diameters downstream from duct collar.

2.04 FUME HOODS

A. General Requirements:
   1. Comply with SEFA 1.
      a. Provide fume hoods UL listed and labeled for compliance with UL 1805.
   2. Pre-pipe fume hoods for service fittings.
   3. Pre-wire fume hoods for light fixtures and receptacles.
      a. Terminate all wiring in a junction box on top of hood.
   4. Metal Finish performance requirements:
      a. Metalic parts shall be polyurethane powder coated.
      b. Abrasion resistance: Maximum weight loss of 5.5 mg. per 100 cycles when tested on a Taber Abrasion Tester #E40101 with 1000 gm wheel pressure and Calibrate #CS10 wheel.
      c. Hardness: Surface hardness equivalent to 4H or 5H pencil.
      d. Humidity Resistance: Withstand 1000-hour exposure in saturated humidity at 54 deg C.
      e. Moisture resistance:
         1) No Visable effect to surface finish after boiling water trickled over test panel inclined at 45 degrees for five minutes.
         2) No visable effect to surface finish following 100-hour continuous application of a water-soaked cellulose sponge, maintained in a wet condition throughout the test period.
         3) Adhesion: Score finish surface of test panel with razor blade into 100 squares, mm 1.5 by 1.5 mm, cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.

4) Salt spray: Withstand minimum 200-hour salt spray test using ASTM B117 or equivalent test method.
5) All tests to be performed by recognized testing laboratory qualified to perform and certify testing.

B. Type CO-3 , Fume Hood: Bicasa RX Smart Series
1. Ventilation: Variable Air Volume (VAV).
2. Configuration: Standing-height; bench mounted.
3. Nominal Interior Height: 51 inches (1295 mm).
4. Nominal depth: 36 inches
5. Nominal width: 83 inches (2100 mm)
6. Sash Type: Vertical/horizontal combination.
a. Leak-free enclosure box, manufacturer's standard construction, for vertical rising sash.
b. Horizontal Sashes: By-passing and removable sashes hung from adjustable nylon-tired, ball-bearing sheaves, supported on an overhead stainless-steel track; lower track only for guiding sashes; flush finger pulls and rubber bumpers at both stiles of each sash.
c. Glazing: Laminated safety glass.
d. Sash Guides: Corrosion-resistant polyvinyl chloride (PVC) track.
e. Vertical Sash mechanism: Designed to prevent sash drop in case of mechanism failure.
1) Cable: Minimum 3/32 inch (2 mm) thick stainless steel of construction standard with the manufacturer.
f. Vertical Sash Pull: Type 316 stainless steel, with PTFE corrosion-resistant coating.
7. Top Front Panel: Standard integral grille stamped into panel of same materials as fume hood exterior.
8. Exterior: Aluminum.
9. Interior Lining: Phenolic composite.
a. Color/Finish: White.
10. Service Fittings and Fixtures:
a. Cup Sink Type: CS-01: Drop-in Epoxy, complete with removable stainer and waste fitting.
1) Shape: Oval.
2) Size: 3 inches by 9 inches (75 by 228 mm).
b. Compressed Air Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
c. Vacuum Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
d. Water Outlet Fitting Assembly: Model L081WSA Remote fitting L2885W manufactured by Watersaver.
e. Vacuum-breaker Assembly: Model L112 manufactured by watersaver.
f. Escutcheons: Manufacturer's standard.
11. Access Panels: Provide removable panels on both sides hood exterior and interior lining panels.
12. Work Surface:
a. Work Top for Fume Hoods Other Than Floor-mounted Type: High temperature/ chemically resistant. Ceramic/Stonehard or accepted alternate..
1) Edge: Raised rim with rounded edges and corners.

C. Type MS-10 , Fume Hood: Bicasa RX Smart Series

1. Ventilation: Variable Air Volume (VAV).
2. Configuration: Standing-height; bench mounted.
3. Nominal width: 83 inches (2100 mm)
4. Nominal depth: 36 inches
5. Nominal Interior Height: 51 inches (1295 mm).
6. Sash Type: Vertical/horizontal combination.
   a. Configuration: As indicated on drawings.
   b. Leak-free enclosure box, manufacturer's standard construction, for vertical rising sash.
   c. Horizontal Sashes: By-passing and removable sashes hung from adjustable nylon-tired, ball-bearing sheaves, supported on an overhead stainless-steel track; lower track only for guiding sashes; flush finger pulls and rubber bumpers at both stiles of each sash.
   d. Glazing: Laminated safety glass.
   e. Sash Guides: Corrosion-resistant polyvinyl chloride (PVC) track.
   f. Vertical Sash mechanism: Designed to prevent sash drop in case of mechanism failure.
   g. Vertical Sash Pull: Type 316 stainless steel, with No.4 finish.
   h. Sliding Safety Shield: Manufacturer's standard removable polycarbonate shield able to slide the full width of fume face opening, with ball-bearing rollers at top for suspension from track at top of sash opening, and guide at bottom to keep shield from swinging.
7. Top Front Panel: Standard integral grille stamped into panel of same materials as fume hood exterior.
8. Exterior: Aluminum
9. Service Fittings and Fixtures:
   a. As specified in 123553.13 - Metal Laboratory Casework.
      1) Sink Type:[SK-02]: Drop-in Epoxy, complete with removable stainer and waste fitting.
      2) Shape: Square
      3) Size: 16" X 16"
   b. Compressed Air Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
   c. Vacuum Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
   d. Water Outlet Fitting Assembly: Model L081WSA Remote fitting L2885W manufactured by Watersaver.
   e. Vacuum-breaker Assembly: Model L112 manufactured by Watersaver.
   f. Escutcheons: Manufacturer's standard.
10. Access Panels: Provide removable panels on both sides hood exterior and interior lining panels.
11. Work Surface:
    a. Work Top for Fume Hoods Other Than Floor-mounted Type: High temperature/ chemically resistant. Ceramic/Stonehard or accepted alternate..

D. Type CH-5 , Fume Hood: Bicasa RX Smart Series
   1. Ventilation: Variable Air Volume (VAV).
   2. Configuration: Bench mounted.
   3. Nominal width: 71 inches (1800 mm)
   4. Nominal depth: 36 inches

5. Nominal Interior Height: 51 inches (1295 mm).
6. Sash Type: Vertical rising.
    a. Configuration: As indicated on drawings.
    b. Leak-free enclosure box, manufacturer's standard construction, for vertical rising sash.
    c. Glazing: Polycarbonate.
    d. Sash Guides: Corrosion-resistant polyvinyl chloride (PVC) track.
    e. Vertical Sash Mechanism: Design to prevent sash drop in case of mechanism failure.
        1) Cable: Minimum 3/32 inch (2 mm) thick stainless steel of construction standard with the manufacturer.
    f. Vertical Sash Pull: Type 316 stainless steel, with No.4 finish.
7. Interior Lining: 3/16 inch thick glass fiber reinforced polyester.
8. Service Fittings and Fixtures:
    a. Specialty Gas Fitting Assembly: (Nitrogen) Model CT022WSA remote fitting L2885N manufactured by WaterSaver.
    b. Compressed Air Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
    c. Vacuum Outlet Fitting Assembly: Model CT022WSA remote fitting L2885N manufactured by Watersaver.
    d. Water Outlet Fitting Assembly: Model L081WSA Remote fitting L2885W manufactured by Watersaver.
    e. Vacuum-breaker Assembly: Model L112 manufactured by Watersaver.
    f. Escutcheons: Manufacturer's standard.
9. Access Panels: Removable panels on both sides hood exterior and interior lining panels.
10. Work Surface:
    a. Work Top for Fume Hoods Other Than Floor-mounted Type: _____.
        1) Edge: Raised rim with rounded edges and corners.

E. Fume Hood Base Cabinets:
1. See Section 123553.13 - Metal Laboratory Casework.
2. Exterior construction: Metal cabinets.
    a. Acid storage cabinets.
    b. Solvent storage cabinets.
    c. Vacuumpump cabinets.
3. Material: Sheet steel.
4. Color/Finish: As selected from manufacturer's standard line..

F. Light Fixtures: UL labeled, vaporproof, _____, _____ LED light fixtures. Number and length of fixtures as necessary for fume hood width. Mounted above sealed safety glass panel. White baked-enamel finish on fixture interior.

2.05 FABRICATION

A. General: Assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations, or as necessary to permit movement through a 35 inches by 79 inches (889 mm by 2007 mm) clear door opening.

B. Aluminum Exterior, Air foil, and sash.
1. Aluminum extruded profiles with internal compartment and snap fit removable panel, side wall total thinkness - 1 31/32"

C. Ends: Fabricated with double-wall end panels. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.

D. Lining Assembly: Unless otherwise indicated, Molded unit, consisting of end and back panels bonded together with epoxy adhesive, concealed where possible. Joints sealed by filling with chemical-resistant sealant during assembly.
   1. Punched fume hood lining side or bottom panels for service fittings and remote controls. Removable plug buttons for holes not used for indicated fittings.

E. Rear Baffle: Same material as fume hood lining, unless otherwise indicated, at rear of hood with openings at top and bottom, with corrosion-resistant fasteners. Fabricated for removal to facilitate cleaning behind baffle.

F. Exhaust Plenum: Full width of fume hood, sized and configured to provide uniform airflow, of same material as hood lining, and with duct stub for exhaust connection.
   1. Duct-Stub Material: Epoxy-coated steel, unless otherwise indicated.

G. Airfoil: At bottom of fume hood face opening, with 1 inch (25.4 mm) gap between bottom of airfoil and work top. Sash to close on top of airfoil. Designed to direct airflow across work.
   1. Fabricated from Aluminum

H. Comply with requirements of other sections for factory installation of water and laboratory gas service fittings, piping, electrical devices, and wiring. Securely anchor fittings, piping, and conduit to fume hoods, unless otherwise indicated.

2.06 MATERIALS

A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

B. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666/A666M, Type 304, stretcher-leveled standard of flatness.

C. Aluminum: Coated exterusions, 1 31/32" total thickness of wall panels.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fasteners: Stainless-steel, where exposed to fumes.

2.07 ACCESSORIES

A. Airflow Monitors/Indicators and Alarms: Provide each fume hood with a airflow monitor/indicator complete with an audible and visual alarm that activates when airflow sensor reading is outside of preset range.
   1. Source: Fume hood manufacturer.
   2. Airflow Monitor/Indicator Functionality:
   3. Airflow Alarm functionality: Audible (85 dB @ 4 inch (102 mm) distance), and visual alarm that activates when airflow sensor reading is outside of preset range.
      a. Reset and test mode.
      b. Programmable Switch: Designed to silence audible alarm and automatically reset when airflow returns to within preset range. Warning light to stay on when alarm is silenced.
      c. Capability for integration with BAS (Building Automation System) via BACnet.

2.08 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory testing of each type of fume hood.

C. Non-Complying Work: See Section 014000.

PART 3 EXECUTION

3.01 EXAMINATION

A. Locate concealed framing, blocking, and reinforcements that support fume hoods by field measurements before being enclosed, and indicate measurements on Shop Drawings.

B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.

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

3.02 INSTALLATION

A. General: Install fume hoods according to manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

B. Comply with indicated requirements for installing water and laboratory gas service fittings, and electrical and telecommunications devices.

3.03 FIELD QUALITY CONTROL

A. Field test fume hoods as specified below.

1. General: Test fume hoods as installed to assess airflow velocity. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for _____ hoods provided in the Project.

3.04 ADJUSTING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand only. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

3.05 CLEANING

A. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

3.06 DEMONSTRATION

A. Demonstrate proper operation of fume hoods and their accessories to Owner's designated representative.

3.07 FUME HOOD SCHEDULE

A. See drawings for Fume Hood Schedule.

END OF SECTION 115313

SECTION 122400
WINDOW SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior manual roller shades.

1.02 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.

B. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.

C. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

1.04 WARRANTY

A. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
   1. Shade Hardware: One year.
   2. Fabric: One year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Interior Manually Operated Roller Shades:
   1. Draper, Inc; Clutch Operated FlexShade: www.draperinc.com/#sle.
   2. Hunter Douglas Architectural; RB500 Manual Roller Shades: www.hunterdouglasarchitectural.com/#sle.
   3. MechoShade Systems LLC; Mecho/7 System: www.mechoshade.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.

B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

END OF SECTION 122400

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SECTION 123553.13
METAL LABORATORY CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Standard and custom metal cabinets and cabinet hardware.
B. Mobile cabinets.
C. Tables.
D. Wall shelving.
E. Fixed- and adjustable-height workbenches.
F. Service space framing.
G. Service enclosures.
H. Acid storage cabinets.
I. Solvent storage cabinets.
J. Vacuum pump cabinets.
K. Ceiling service panels.
L. Countertops.
M. Ledges.
N. Laboratory sinks.
O. Pegboards.
P. Laboratory emergency equipment plumbing fixtures.
Q. Service fittings and outlets.

1.02 RELATED REQUIREMENTS

A. Section 260533.23 - Surface Raceways for Electrical Systems: Surface raceway systems.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014.
C. ASTM A513/A513M - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing; 2025.
D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.
F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
G. ASTM D522/D522M - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings; 2017 (Reapproved 2021).
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

I. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

J. BHMA A156.9 - Cabinet Hardware; 2020.

K. ICC (IFC) - International Fire Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 1 - Fire Code; 2024, with Errata.

M. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Errata (2025).

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. SEFA 1 - Laboratory Fume Hoods; 2010.

P. SEFA 2 - Installations; 2010.

Q. SEFA 3 - Laboratory Work Surfaces; 2020.

R. SEFA 7 - Laboratory Fixtures; 2021.

S. SEFA 8M - Laboratory Grade Metal Casework; 2020.

T. SEFA 10 - Adaptable Laboratory Furniture Systems; 2013.

U. SEFA 11 - Liquid Chemical Storage Cabinets; 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of casework with related items.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate casework types, sizes, and locations, using large scale plans, elevations, and cross sections. Include rough-in and anchors and reinforcements placement dimensions and tolerances, clearances required, and utility locations, if any. Include coordinated information for laboratory equipment specified in another section and/or furnished by Owner.

C. Test Reports: Independent laboratory reports showing compliance with chemical and physical resistance requirements for casework finish and countertops.

D. Maintenance Data: Manufacturer's recommendations for care and cleaning.

E. Finish touch-up kit for each type and color of materials provided.

1.06 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect items provided by this section, including finished surfaces and hardware items during handling and installation. For metal surfaces, use polyethylene film or other protective material standard with the manufacturer.

1.08 MOCK-UPS

A. Provide full size base cabinet complete with drawers, door, adjustable shelf and countertop.

B. See Section 014000 - Quality Requirements for additional requirements.

C. Locate where directed.

D. Mock-up may remain as part of the work.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Casework manufacturer Warranty: Provide 5-year warranty against defects. Complete forms in Owner's name and register with manufacturer. Covered defects include, but are not limited to:
   1. Ruptured, cracked, or stained finish coating.
   2. Discoloration, or lack of finish integrity.
   3. Cracking or peeling of finish.
   4. Weld or any other structural failure.
   5. Failure of hardware.

C. Counter manufacturer Warranty: Provide 10 warranty against defects. Complete forms in Owner's name and register with manufacturer. Covered defects include, but are not limited to:
   1. The warranty to include the specified physical and chemical properties. The manufacturers authorized fabricator, product installer and panel manufacturer must sign the warranty documents and submit a copy to the contractor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Laboratory Casework:
   1. Bicasa USA www.bicasa.it/en/. Basis of Design
   2. Waldner NA www.wnalabs,com
   3. Kewaunee Scientific Corp;[____]: www.kewaunee.com/#sle.

B. Countertops:
   1. Phenolic Resin:
      a. Trespa Top Lab plus
      b. Fundermax CTC, Basis of Design
   2. Stainless Steel
      a. Integral sinks, backspash, or trough.
      b. Marine grade playwood underlayment.
   3. High Temperature counter
      a. Ceramic/Stoneware
         1) Basis of Design: Stoneware, Waldner Laboratory Furniture, or accepted alternate by accepted casework vendor.

C. Sinks and Cup Sinks:
   1. Durcon (Epoxy resin, Polyolefin); ____: www.durcon.com/#sle.
   2. Scientific Plastics, Inc. (Polyolefin); ____: www.scientificplastics.com/#sle.
   3. Substitutions: See Section 016000 - Product Requirements.

D. Water and Gas Service Fittings:
   1. Broen-Lab A/S; ____: www.broen-lab.com/#sle.
   2. Chicago Faucets, a Geberit company; ____: www.chicagofaucets.com/#sle.
   3. WaterSaver Faucet Co; Basis of Design: www.wsflab.com/#sle.

2.02 METAL LABORATORY CASEWORK

A. Casework: Die-formed metal sheet; each unit self-contained and not dependent on adjacent units or building structure for rigidity; factory-fabricated, factory-assembled, and factory-finished.
   1. Basis of Design: Bicasa Metal Casework, Arctic White
      a. Casework hieghts as noted on the drawings
   2. Style: Flush overlay - square edge.
   3. Cabinet Nominal Dimensions: Unless otherwise indicated, provide cabinets of widths and heights indicated on drawings, and with following front-to-back dimensions.
      a. Base Cabinets: 22 inch (559 mm).
      b. Tall Cabinets: 22 inch (559 mm).
      c. Upper Cabinets: 13 inch (330 mm).
   4. Steel Sheet Metal:
      a. Gables, Front and Back Panels, Gusset Plates, Aprons, and Rails: 18 gauge, 0.0478 inch (1.21 mm) minimum thickness.
      b. Drawers, Cabinet Floors, Shelves, Filler Panels and Drawer Dividers: 20 gauge, 0.0359 inch (0.91 mm) minimum thickness.
      c. Backing Sheet to Door and Door Fronts: 22 gauge, 0.0299 inch (0.76 mm) minimum thickness.
   5. Structural Performance: In addition to the requirements of SEFA 3, SEFA 7 and SEFA 8M, provide components that safely support the following minimum loads, without deformation or damage:
      a. Base Units: 500 pounds per linear foot (744 kg/linear m) across the cabinet ends.
      b. Suspended Units: 300 pounds (136 kg), minimum, static load.
      c. Tables: 300 pounds (136 kg) on four legs.
      d. Drawers: 125 pounds (57 kg).
      e. Hanging Upper Cases: 300 pounds (136 kg).
      f. Shelves: 100 pounds (45 kg).
   6. Corners and Joints: Without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
   7. Edges and Seams: Smooth. Form counter tops, shelves, and drain boards from continuous sheets.
   8. Shelf Edges: Turned down 3/4 inch (19 mm) on each side and returned 3/4 inch (19 mm) front and back.
   9. Ends: Close open ends with matching construction.
   10. Welding: Electric spot welded; joints ground smooth and flush.
   11. Drawers and Doors: Fabricate drawer and door fronts of sandwiched sheets of sheet steel welded together and reinforced for hardware.
      a. Fill with sound-deadening core.
   12. Glazing: Type and thickness standard with manufacturer.
      a. Framed Doors: Tempered glass, with gaskets and removable stops; minimize rattling and vibration.
   13. Fittings and Fixture Locations: Cut and drill countertops, backs, and other casework components for service outlets and fixtures.
   14. Access Panels: Where indicated, for maintenance of utility service fixtures and fittings and mechanical and electrical components.
   15. Removable back panels on all base cabinets. Partial height back panels at sink cabinets.
   16. Filler Panels: Flanged on both sides, of matching construction and finish, for locations where cabinets do not fit tight to adjacent construction.
   17. Scribe Panels: Similar to filler panels, except flanges on one side and flat on the other, of matching construction and finish.

18. Stainless Steel Finish: No.4, brushed finish.
19. Separation: Use bituminous paint or non-conductive tape to coat metal surfaces in contact with cementitious materials, and to separate dissimilar metals.

B. Mobile Cabinets: Same construction as fixed base cabinets, with modifications.
   1. Toe kick space eliminated.
      a. Cabinet underside reinforced with 14 gauge, 0.0747 inch (1.9 mm) minimum steel channels to provide caster mounting points.
      b. Four casters, each with a load rating of 165 pounds (74.8 kg).
   2. Provide 1/2" thick phenolic top, mobile cabinets must fit under cabinets where indicated.
   3. For cabinets with drawers, include a counterweight to prevent the cabinet from tipping when one drawer is opened.
      a. Drawers rated at 50 pounds (22.7 kg), minimum.

C. Acid Storage Cabinets: Construction identical to other cabinets, with following exceptions:
   1. Completely lined with corrosion-resistant liner material; stainless steel fasteners for all connections and hardware inside cabinet.
   2. Shelves: Perforated or vented, rigid polypropylene.
   3. Bottom Pan: Liquid tight, polypropylene liner covering entire bottom of acid storage cabinet.
   4. Vents: Comply with SEFA 1.
      a. Locate acid storage cabinet vents in accordance with manufacturer's instructions.
      b. Vent each acid storage cabinet separately.
      c. When acid storage cabinets are installed below fume hoods, provide louvered cabinet doors.
      d. Seal penetrations with chemical resistant sealant.

D. Solvent (Flammable and Combustible Liquids) Storage Cabinets: Construction identical to other cabinets, with following exceptions:
   1. Construct to NFPA 30 and applicable OSHA requirements.
   2. Fire Resistance: Maximum internal temperature of 325 degrees F (163 degrees C) at the center, and 1 inch (25.4 mm) from top of the cabinet when cabinet is subjected to a ten minute fire test that simulates fire exposure of a standard time-temperature curve specified in ASTM E119.
   3. Steel sheet, 18 gauge, 0.0478 inch (1.21 mm) minimum thickness, double panel construction with 1-1/2 inch (38 mm) space between panels and electrical grounding connection.
   4. Shelves: Full depth, adjustable sloped metal shelf.
   5. Bottom Pan: 2 inches (50.8 mm) deep liquid-tight pan covering entire bottom of cabinet.
   6. Cabinet Hardware: UL-listed.
      a. Hinges: Full-length stainless steel continuous (piano) hinges.
      b. Self-closing Doors: Comply with requirements of NFPA 1 and ICC (IFC). Minimum 90 degree opening. Three-point latch arrangement, door(s) shutting and latching automatically when hold-open device's fusible link melts at 165 degrees F (74 degrees C) under fire conditions outside the cabinet. At pair of doors, synchronize latching so that both doors always fully close.
      c. Door Handles: Manufacturer's standard, with slip-resistant grip.
      d. Grounding screw-lug.
   7. Signage: Provide manufacturer's standard signage reading "FLAMMABLE - KEEP FIRE AWAY" or similar message in bright red color.

E. Waste Disposal Cabinets.

1. No cabinet bottom but with integral toe space, removable back panels, and precut 2-1/2 inch (63.5 mm) hole for drainage from fume hood above .
2. Waste Platform: Separate from cabinet, capable of supporting 300 pounds (136 kg), two of four casters to be lockable, swivel-type; 2 inch (50.8 mm) lip and liquid tight pan covering entire bottom of cabinet.

F. Vacuum Pump Cabinets: Construction identical to other cabinets, with following exceptions:
1. No cabinet bottom but with integral toe space, removable back panels, and precut 2-1/2 inch (63.5 mm) vent hole for separate vent assembly.
2. Insulation: Manufacturer's standard acoustical insulation on interior of door panels, interior side of back and panels as well as underside of top panel.
3. Motor Platform: Separate from cabinet, capable of supporting 300 pounds (136 kg), two of four casters to be lockable, swivel-type; 2 inch (50.8 mm) lip and liquid tight pan covering entire bottom of cabinet.
4. Pump On/Off Switch: Integral, 120V, 20A, with pilot light indicating availability of power and mode of vacuum pump operation.
   a. Conduit Stub: 20 foot (6 m), 1/2 inch (13 mm) flexible metal conduit connected to switch, for connection to building power.
5. Convenience Outlet: Integral electrical duplex outlet located in rear of cabinet, accessible from inside cabinet and pre-wired to pump on/off switch.

G. Tables: Include adjustable height units.
1. Adjustable Height Table Construction: Manufacturer's standard, with countertop worksurfaces, unless noted otherwise.
   a. Cantilevered Base Frame: Each base equipped with a pair of glides or leveling swivel casters as noted.
   b. Worksurface Support Frame: Telescoping from base frame.
   c. Worksurface: Phenolic Resin.
      1) Lift Capacity: 1,000 lb (454 kg), evenly distributed on worksurface.
      2) Adjustability:
         (a) Total Range: 14 inches (356 mm).
         (b) Manual Operation: Threaded fastener pins inserted into holes on 1 inch centers (on 25.4 mm centers).
      3) Finish, Surface Color, and Texture: As selected by Architect from manufacturer's standard line.
2. Accessory Components: Manufacturer's standard.
   a. Storage and Display Components: Sizes and configurations indicated on drawings.
      1) Storage cabinets.
      2) Cabinet Hardware: Manufacturer's standard types as required for drawers, doors, shelves, levelers, and similar items.
   b. Computer Support Components: Sizes and configurations indicated on drawings.
      1) Tower dolly.
      2) Computer monitor arm.
3. Primary Materials: Manufacturer's standard for each component.
   a. Tubing: Hot-rolled steel, ASTM A513/A513M.
   b. Sheet Metal: Cold-rolled steel, ASTM A1008/A1008M.
   c. Metal Finish Color: Arctic white.

H. Wall Shelving: At locations indicated.

1. Adjustable Shelf Supports: Standard back-mounted system using single-slotted surface mounted stainless steel shelf standards, in lengths indicated, with coordinated cantilevered shelf brackets, No.4 finish, designed for nominal 1 inch (25 mm) spacing adjustments.
2. Shelves: 3/4 inch thick (19 mm thick) phenolic resin shelves in lengths indicated.
   a. Depth: 12 inches (305 mm).

I. Apron Assemblies: Construction similar to other cabinets, fabricated from metal channel-shaped skirting panels.
1. Assemblies consisting of front and back panels, with drawer suspension framing mechanically fastened to support channels. Weld support channels to skirting panels to form a riding one-piece frame.

J. Vertical Service Drop Enclosures: Where indicated on drawings, for service drops to metal casework.
1. Frames: Unless otherwise standard with the manufacturer, channel strut frames, with members at all corners, bottom, mid-height, and top of enclosure. Designed for anchorages at the bottom to countertop, and at top to miscellaneous metal support framing.
2. Enclosures: Consisting of fixed and removable (access) panels, in configuration standard with the manufacturer.
   a. Extent: Up to underside of ceiling.
   b. Rear Panel: Fixed panel, constructed like other casework closure panels.
   c. Side Panels: Fixed panels, constructed like other casework closure panels.
   d. Front Panels:
      1) Fixed Panel: Metal panel, constructed like other casework closure panels.
      2) Removable (Access) Panel: Metal panel, constructed like other casework closure panels.
   e. Attachment: Use corrosion-resistant metal mounting hardware and fasteners.
      1) Removable Panels: Mount with z-clips, welded-on pins and keyhole slots, or similar non-permanent means.

K. Ceiling Service Panels: Designed to integrate into acoustical panel suspension grids for delivering multiple plumbing, electrical and data services.
1. Fabricated to fit in standard 24 inches by 24 inches (600 mm by 600 mm) ceiling grids.
2. Enclosure Material: 18 gauge sheet steel with chemical-resistant finish specified herein.
3. Required Fitting Types: Quick-connect fittings and hoses.
4. Service Panel Types: Pre-punched panels accepting groups of services.
   a. Two-Station, 24 inches by 24 inches (600 mm by 600 mm) panel: Two (2) groups of six (6) service cutouts; Four (4) duplex receptacles cutouts; Two (2) data outlet cutouts.
5. Quick-Connect Fittings: Male and female types, suitable for service connected, 3/8 inch NPS (10 mm DN).
   a. Provide in up to eight different sizes (keys) to prevent connecting to wrong service.
6. Accessories:
   a. Service Hoses.
      1) Reinforced PVC Hoses: Provide for non-burning gases, 3/8 inch NPS (10 mm DN) female inlet and 3/8 inch NPS (10 mm DN) male outlet. 36 inch (914 mm) length.
   b. Power Cords.
      1) Dual-circuit, 4-wire, 20 AMP/120 VAC, 36 inches (914 mm) long, with Twist-Lock plugs.

2.03 FIXED AND ADJUSTABLE WORKBENCHES

A. Basis of Design: Bicasa H-Flex Bench, and K-Flex Systems

B. Type: Adjustable-height unit.

C. Lift Capacity: 750 lb (340 kg), evenly distributed on worksurface.

D. Primary Components: Manufacturer's standard; consisting of cantilevered base frame, worksurface support frame, and worksurface.
   1. Cantilevered Base Frame: Each base equipped with a pair of glides.
   2. Worksurface Support Frame: Telescoping from base frame.
   3. Worksurface: As indicated on drawings: Phenolic Resin or Wood backed stainless steel..
      a. Adjustability:
         1) Total Range: 15 inches (381 mm).
         2) Operation: Manual.
            (a) Manual Operation: Threaded fastener pins inserted into holes on 1 inch centers (on 25.4 mm centers).
      b. Finish, Surface Color, and Texture: As selected by Architect from manufacturer's standard line.

E. Accessory Components: Manufacturer's standard.
   1. Back Frame: Upright frame for mounting accessory components.
      a. Load Capacity: 250 lb (114 kg), evenly distributed.
      b. Mounting: Bolted to back of worksurface support frame.
      c. Divider Uprights: Flexible locations for subdividing the back frame into smaller sections.
      d. Electric Power Strip: Single receptacles at manufacturer's standard spacing with total current rating of 20 Amp.
   2. Storage and Display Components: Sizes and configurations indicated on drawings.
      a. Shelves.
      b. Storage cabinets.
      c. Cabinet Hardware: Manufacturer's standard types as required for drawers, doors, shelves, levelers, and similar items.

F. Primary Materials: Manufacturer's standard for each component.
   1. Tubing: Hot-rolled steel, ASTM A513/A513M.
   2. Sheet Metal: Cold-rolled steel, ASTM A1008/A1008M.

G. Metal Finish Color: Arctic White.

2.04 CABINET HARDWARE

A. Manufacturer's standard styles, and as indicated below.

B. Comply with BHMA A156.9 requirements.

C. Finish of exposed stainless steel components: No.4 finish.

D. Shelves in Cabinets:

E. Wall-Mounted Shelving:

F. Swinging Doors:
   1. Hinges: Offset pin, number as required by referenced standards for width, height, and weight of door.
      a. Butt Hinges for Inset Doors: five-knuckle, projecting barrel, minimum 2-1/2 inches long (five-knuckle, projecting barrel, minimum 64 mm long). Stainless steel with No.4 finish.

2. Catches: Magnetic.
3. Pulls: Chrome-plated brass wire pulls, 4 inches (102 mm) wide.

G. Drawers:
1. Pulls: Brass wire pulls, 4 inches wide (102 mm wide).
2. Slides: Steel, full extension arms, ball bearings; self-closing; capacity as recommended by manufacturer for drawer height and width.

2.05 COUNTERTOPS

A. Countertops:
1. Types: More than one type is required, as specified below. See drawings for location of each type of countertop.
2. Stainless Steel Countertops: , Type 304, stainless steel sheet; 16 gauge, 0.0625 inch (1.59 mm) nominal sheet thickness.
a. Finish: 4B satin brushed finish.
b. Exposed Edge Shape: Bullnose with return; 5/8 inch (16 mm) radius, return to face of case; reinforced with hardwood or steel.
c. Back and End Splashes: Same material; welded 1/4 inch (6 mm) radius coved joint to countertop; square top edge with 1 inch (25 mm) wide top surface and minimum 1/2 inch (12 mm) turndown.
3. Phenolic Resin Countertops:
a. Phenolic Resin Countertops: duromer high pressure, phenolic, compact laminate (Compact HPL), manufactured under high pressure at high temperature, in accordance with EN 438-4, type CGS. Layers of recycled kraft paper impregnated with phenolic resin with, double-cured polyurethane acrylic coating.
b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Fundermax Max Resistance [2] Color-Through Core
2) Trespa Top Lab Plus
3) Chem Tops Lab Grade SPC
c. Counter;
1) Flat Surface Thickness: 1 inch (25 mm), nominal.
2) Surface Finish: Smooth, non-glare.
3) Color: Gray.
4) Exposed Edge Shape: 1/8 inch (3 mm) bevel chamfer.
5) Back and End Splashes: Same material, same thickness; separate for field attachment.
d. Physical Properties
1) Density DIN 52350 / ISO 1183: $\geq$ 1,35g/cm^3 / $\geq$ 84lbs/ft^3
2) Modulus of elasticity EN ISO 178: $\geq$ 9000MPa / $\geq$ 1,305,340 psi
3) Modulus of elasticity EN ISO 178: $\geq$ 9000MPa / $\geq$ 1,305,340 psi
4) Tensile Strength EN ISO 527-2: $\geq$ 60 MPa / $\geq$ 8,702 psi
5) Resistance to Scratching EN 438-2 point 25: 4-6 N (6N = 1.35lbf)
6) Resistance to Impact EN 438-2 point 21: $\geq$8mm / $\geq$ 1/3”
7) Resistance to stress Abrasion EN 438-2 point 10: $\geq$ 450 U (rotations)
8) Dimensional stability measured at elevated temperatures with moisture change EN 438-2, point 17: $\leq$ 0.10% length : $\leq$ 0.21% width (CGS)
9) Resistance to boiling water EN 438-2, point 12: 0.5% (CGS/CGF) 1.5 (BCS)
10) Co-efficiency of thermal expansion DIN 52328: 20 x 10^{-6}
11) Resistance to dry heat EN 438-2, point 16: 4

12) Resistance to staining EN 438-2, point 26 (group 1-2): 5 no visible changes, no blisters or cracks
13) Light fastness EN 438-2 point 27: 4 or 5
14) Non porous and non-microporous surface and edges
15) Both sides decorative and chemical resistant
16) Double hardened acrylic surface finish
    (a) Min thickness of the acrylic finish: ≥ 0,1mm / 0.004”
17) Fire Resistive Properties:
    (a) Flame Spread Index: 25
    (b) Smoke Developed Index: 130

e. Chemical Resistance
1) Evaluation of chemical resistance based on SEFA 3-2010 Laboratory Work Surfaces standard list of 49 chemicals / concentrations, their required methods of testing (24-hour surface test) and exceed the acceptable results as a means of establishing an acceptable level of performance for all exposed and semi-exposed surfaces.
2) The chemical resistance performance should be as follows:
    (a) Rating Scale:
        (1) *Level 0 - No detectable change.*
        (2) *Level 1 - Slight change in color or gloss.*
        (3) *Level 2 - Slight surface etching or severe staining.*
        (4) *Level 3 - Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.*
    (b)

CHEMICAL/REAGENT	TEST METHOD	RATING
ACETATE, AMYL	A	0
ACETATE, ETHYL	A	0
ACETIC ACID - 98%	B	0
ACETONE	A	0
ALCOHOL, ETHYL	A	0
ALCOHOL, METHYL	A	0
ALOCHOL, BUTYL	A	0
AMMONIUM HYDROXIDE, 28%	B	0
BENZENE	A	0
CARBON TETRACHLORIDE	A	0
CHLOROFORM	A	1
CHROMIC ACID - 60%	B	0
CRESOL	A	1
DICHLORACETIC ACID	A	2
DICHROMATE ACID 5%	B	1
DIMETHYLFORMAMIDE	A	0
DIOXANE	A	0
ETHYL ETHER	A	0
FORMALDEHYDE, 37%	A	0

FORMIC ACID - 90%	B	1
FURFURAL	A	1
GASOLINE	A	0
HYDROCHLORIC ACID 37%	B	0
HYDROFLUORIC ACID, 48%	B	1
HYDROGEN PEROXIDE, 30%	B	2
IODINE, TINCTURE OF	B	1
METHYL ETHYL KETONE	A	0
METHYLENE CHLORIDE	A	0
MONOCHLOROBENZENE	A	0
NAPTHALENE	A	0
NITRIC ACID 20%	B	0
NITRIC ACID 30%	B	0
NITRIC ACID 70%	B	0
PHENOL, 90% (WT)	A	1
PHOSPHORIC ACID 85%	B	0
SILVER NITRATE, SATURATED	B	0
SODIUM HYDROXIDE FLAKE	B	0
SODIUM HYDROXIDE, 10% (WT)	B	0
SODIUM HYDROXIDE, 20% (WT)	B	0
SODIUM HYDROXIDE, 40% (WT)	B	0
SODIUM SULFIDE SATURATED	B	0
SULFURIC ACID, 33%	B	0
SULFURIC ACID, 77%	B	0
SULFURIC ACID, 77% & NITRIC ACID, 70% EQUAL PARTS	B	2
SULFURIC ACID, 96%	B	1
TOLUENE	A	0
TRICHOLOROETHYLENE	A	0
XYLENE	A	0
ZINC CHLORIDE, SATURATED	B	0

f. Phenolic resin tops shall be designed to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness, and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops and curbs shall be non-glaring Grey in color. (Color shall be approved by the Owner.)
   1) Seams and Joints: Tight fitting butt joints adhered with reactive adhesive/resin adhesive. Countertop shall be installed square level and flat, sealing seams shall not occur until counters are set square, level and flat.
   2) Table tops shall be 1" thick, with drip grooves provided on the underside at all exposed edges.
   3) Sinks: Provide epoxy undermount sinks per section below.
      (a) Under Mount – routed to form smooth edged openings with the top edge radius. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radius not less than 1/8”. All undermount sinks shall be supported by brackets blind fixed to the underside of the work surface and/or cabinet.

4. Heat/Chemical Resistant Counter: Stonehard, by Waldner, or approved substitution by accepted casework vendor.
   a. Heat Tolerance Requirements: 200 C
   b. Chemical Resistance: Able to resist use of HF, Li+, HNO3, H2SO4 and H2O2 without damage or staining.

2.06 LEDGES

A. Subsidiary tops, at same or different level than main countertops, intended as mounting surfaces for lab services fittings.

B. Material: Matching countertops.

2.07 SINKS

A. Laboratory sinks.
   1. General: Manufacturer's adjustable support system for undermount sink installation.
   2. Sink types and sizes are indicated on drawings.
   3. Sink Type: SK-01 : Single-bowl.
      a. Basis of Design: Model U56C manufactured by Durcon.
      b. Basis of Design: Model D15C manufactured by Durcon.
      c. Material: Epoxy.
      d. Mounting: Undermount.
      e. Outlet: 1-1/2 inch NPS (40 mm DN) outlet with tailpiece.
   4. Sink Type: SK-01A : Single-bowl.
      a. Material: Stainless Steel.
      b. Mounting: Intergral
      c. Outlet: 1-1/2 inch NPS (40 mm DN) outlet with tailpiece.
         1) Placement: Center.
      d. Placement: Center.
   5. Sink Type: SK-02 : Single-bowl.
      a. Material: Polyolefin.
      b. Mounting: Drop-in. In fume hood
      c. Outlet: 1-1/2 inch NPS (40 mm DN) outlet with tailpiece.
         1) Placement: Center.
   6. Cup Sink Type: CS-01: Polyolefin, with waste fitting.
      a. Shape: Oval.

b. Size: 3 inches by 9 inches (75 by 228 mm).

2.08 PEGBOARDS

A. Epoxy pegboards with pre-drilled or punched holes in a staggered pattern, designed to accept removable white polypropylene pegs. With each pegboard include a stainless steel drip-trough with drain outlet and matching diameter 36 inch (914 mm) long PVC drain hose.
   1. Size: 24 inches wide by 30 inches high (610 mm wide by 762 mm high).
   2. Accessories: Screen insert.

2.09 LABORATORY EMERGENCY EQUIPMENT PLUMBING FIXTURES

A. General: Provide emergency equipment products complying with requirements of ANSI Z358.1.

B. Eye/Face Wash Units: Deck-mounted units at sinks.
   1. Construction: Polished chrome-plated brass.
   2. Twin eyewash heads with pop-off dust covers, internal flow control, and filter.
   3. Type _____: 90-Degree horizontal-swivel, designed for mounting at either side of sink, with flag-handle activation.
      a. Plug-type valve designed to open orifice and activate water flow only when unit is swung down into operational position.
   4. Sign: Manufacturer's standard ANSI-compliant identification sign.
   5. Manufacturers:

C. Eyewash/Safety Shower Combination Units: Recessed into wall construction.
   1. Cover/Eyewash Drain Pan: Combination fixture, with projecting activation handle requiring grasping and pulling down into operating position for activation.
      a. Plug-type valve designed to open orifice and activate water flow only when unit is swung down into operational position
      b. Twin eyewash heads mounted on supply arms, with internal flow control, and filter.
   2. Shower Head: 10 inch (254 mm) diameter stainless steel, with 20 gallons per minute (4.15 L/s) flow control.
      a. Mounting: Below finished ceiling. Include vertical supply pipe and ceiling escutcheon.
      b. Offset Dimension from Wall to Centerline of Head: 36 inches, barrier-free (915 mm, barrier-free).
   3. Cabinet: Designed for recess into 3-5/8 inch (92 mm) minimum depth metal-framed wall construction.
      a. Mounting: Mount at height complying with ADA Standards.
   4. Activation Handle: Recessed into cabinet, projecting 1-7/8 inches (48 mm) maximum beyond face of wall, and requiring pushing down for activation.
      a. Grip: Manufacturer's standard vinyl grip.
   5. Water Supply: 1 inch NPS FPT (25 mm DN); 35 psi (241 kPa), minimum pressure.
   6. Drain Outlet: 2 inch NPS FPT (50 mm DN).
   7. Manufacturers:
      a. Watersaver.
      b. Guardian.

2.10 SERVICE FITTINGS

A. General: Comply with requirements of SEFA 7.

B. Gas Service Fittings and Fixtures.
   1. Laboratory Gas Fitting Type: CA-01:
      a. Basis of Design: Model L4880F-225WSA manufactured by Watersaver.

b. Valve: Forged or cast brass body, 90 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
c. Control: Needle valve.
d. Mounting: Panel (vertical surface).
e. Outlet: Manufacturer's standard, with removable seven-serration hose end.
1) Number: One.

2. Laboratory Gas Fitting Type: CA-02:
a. Basis of Design: Model L4880F-132AWSA manufactured by Watersaver.
b. Valve: Forged or cast brass body, 90 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
c. Control: Needle valve.
d. Mounting: Deck (horizontal surface) turret base.
e. Outlet: Manufacturer's standard, with removable seven-serration hose end.
f. Handle: Manufacturer's standard four-arm handle with color-coded index disc.

3. Vacuum Fitting Type: VAC-01:
a. Basis of Design: Model L4880F-225WSA manufactured by Watersaver.
b. Valve: Forged or cast brass body, 180 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
c. Control: Needle valve.
d. Mounting: Panel (vertical surface).
e. Inlet: 3/8 inch NPS (10 mm DN) NPT.
f. Outlet: Manufacturer's standard, with removable seven-serration hose end.
1) Number: One.
g. Handle: Manufacturer's standard four-arm handle with color-coded index disc.

4. Vacuum Fitting Type: VAC-02:
a. Basis of Design: Model L4880F-132AWSA manufactured by Watersaver.
b. Valve: Forged or cast brass body, 180 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
c. Control: Needle valve.
d. Mounting: Deck (horizontal surface) turret base.
e. Inlet: 3/8 inch NPS (10 mm DN) NPT.
f. Outlet: Manufacturer's standard, with removable seven-serration hose end.
1) Number: Two.
g. Vacuum Fitting Type: V, CA, N at fume hoods:
1) Basis of Design: Model L2885N/L022WSA manufactured by Watersaver.
2) Valve: Forged or cast brass body, 180 degree inlet - outlet configuration, with polished chrome with clear epoxy coating finish.
3) Control: Needle valve.
4) Mounting: Remote fume hood mounting.
5) Inlet: 3/8 inch NPS (10 mm DN) NPT.
6) Outlet: Manufacturer's standard, with removable ten-serration hose end.
7) Handle: Manufacturer's standard color-coded molded nylon hooded handle with color-coded index disc.

C. Water Service Fittings and Fixtures.
1. Water Fitting Mixing faucetType: F-01:
a. Basis of Design: Model L2224VB manufactured by Watersaver.
b. Valve: Forged or cast brass body, 180 degree inlet - outlet configuration, with polished chrome finish.
c. Mounting: Deck (Horizontal surface) turret base, with escutcheon.

d. Inlet: 3/8 inch NPS (10 mm DN) NPT.
e. Outlet: Manufacturer's standard, with anti-splash serrated hose end.
1) Number: One.
f. Handle: Manufacturer's standard wrist-blade handle with color-coded index disc.
2. Water, Single Faucet Type: F-02:
a. Basis of Design: Model L084 WSA manufactured by Watersaver.
b. Valve: Forged or cast brass body, 180 degree inlet - outlet configuration, with color epoxy coating finish.
c. Mounting: Deck (horizontal surface) turret base.
d. Inlet: 3/8 inch NPS (10 mm DN) NPT.
e. Provide vacuum breaker.
f. Gooseneck: Swing gooseneck, with 6 inch (153 mm) spread, anti-splash serrated hose end.
g. Handle: Manufacturer's standard remote fume hood fitting handle with color-coded index disc.

D. Electrical Fittings and Fixtures:
1. Electrical Fittings, General: Types indicated, for mounting on laboratory casework, including, as appropriate, grounding screws, and mounting accessories and fasteners.
2. See Section 260533.23 for surface raceway systems.
3. Pedestal Boxes: Cast aluminum.
a. Finish: Epoxy powder coating, wrinkle black.
4. Electrical Power Fitting Type: See electrical drawings and specification:
a. General: 3-wire polarized receptacles meeting requirements of NFPA 70.
b. Mounting: Pedestal, surface-mounted.
c. Receptacles: Quadruplex, 5-20R, GFCI.on island benches as noted
d. Twist-Lock Receptacles: Single, L6-20R, GFCI. at Ceiling service panels (CSP)

E. Telecommunications: Manufacturer's standard complete fittings, in design compatible with electrical fittings.
1. See Section 260533.23 for surface raceway systems.
2. Devices provided, and wired by Owner's separate contractor.

2.11 SERVICE SPACE FRAMING

A. Support Framing Units: Galvanized steel framing units at space between back-to-back cabinets and between backs of cabinets and wall surfaces:
1. Manufacturer's standard assemblies.

2.12 MATERIALS

A. Sheet Steel: High-strength low-alloy, cold rolled and leveled unfinished steel sheet, ASTM A1008/A1008M, Class 1 (matte) finish.

B. Stainless Steel Sheet: ASTM A666/A666M, Type 304.

2.13 FINISHES

A. Sheet Steel Finish: Having chemical resistance equal to Level 0 (no change) or Level 1 (slight change of gloss or slight discoloration) according to SEFA 8M. Test applied finishes using procedures specified in ASTM D522/D522M.
1. Coating Type, New Casework: Baked on epoxy; minimum two coats.
2. Color: As selected from manufacturer's standard selection.
3. Preparation: Degrease and phosphate etch, and prime.

2.14 ACCESSORIES

A. Gas Cylinder Brackets: Restraint safety assemblies for laboratory gas cylinders.
   1. Regulatory Compliance: OSHA and NFPA.
   2. Bracket Mounting: Wall, with fasteners.
   3. Cylinder Capacity: Two
   4. Cylinder Diameter Capability: 4 to 12 inches (102 to 305 mm).
   5. Bracket Construction: 11 gauge, 0.119 inch (3.04 mm) hot-rolled steel.
   6. Steel Finish: Polyester powder-coat.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of support framing and anchors.

B. Verify that service connections are correctly located and of proper characteristics.

3.02 INSTALLATION

A. Perform installation in accordance with manufacturer's instructions and with SEFA 2.

B. Use anchoring devices to suit conditions and substrate materials encountered. Use concealed fasteners to the greatest degree possible. Use exposed fasteners only where allowed by approved shop drawings, or where concealed fasteners are impracticable.

C. Set casework items plumb and square, securely anchored to building structure, with no distortion.
   1. Base Cabinets: Examine floor levelness and flatness of installation space. Do not proceed with installation if encountered floor conditions required more than 3/4 inch (19 mm) leveling adjustment. When installation conditions are acceptable, for each space, establish the high point of the floor. Set and make level and plumb first cabinet in relation to this high point.

D. Align cabinets to adjoining components, install filler and/or scribe panels where necessary to close gaps.

E. Fasten together cabinets in continuous runs, with joints flush, uniform and tight. Misalignment of adjacent units not to exceed 1/16 inch (1.6 mm). In addition, do not exceed the following tolerances:
   1. Variation of Tops of Base Cabinets from Level: 1/16 inch (1.6 mm) in 10 feet (3 m).
   2. Variation of Faces of Cabinets from a True Plane: 1/8 inch (3 mm) in 10 feet (3 m).
   3. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).
   4. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.6 mm).

F. Separate dissimilar metals to prevent galvanic action.

G. Base Cabinets: Fasten cabinets to service space framing and/or wall substrates, with fasteners spaced not more than 16 inches (407 mm) on center. Bolt adjacent cabinets together with joints flush, tight, and uniform.

H. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

I. Vented Cabinets: Install in strict compliance with manufacturer's written installation instructions.
   1. Install vent kits and connect to exhaust system.
   2. Use only rigid materials for venting. No flexible materials permitted.

J. Replace units that are damaged, including those that have damaged finishes.

3.03 ADJUSTING

A. Adjust operating parts, including doors, drawers, hardware, and fixtures to function smoothly.

3.04 CLEANING

A. Clean casework and other installed surfaces thoroughly.

3.05 PROTECTION

A. Do not permit finished casework to be exposed to continued construction activity.

B. Protect casework and countertops from ongoing construction activities. Prevent installers from standing on or storing tools and materials on casework or countertops.

C. Repair damage that occurs prior to Date of Substantial Completion, including finishes, using methods prescribed by manufacturer; replace units that cannot be repaired to like-new condition.

END OF SECTION 123553.13

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SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Above ground piping.
B. Escutcheons.
C. Fire rated enclosures.
D. Mechanical couplings.
E. Pipe hangers and supports.
F. Pipe sleeves.
G. Pipe sleeve-seal systems.
H. Piping specialties.
I. Pressure gauges.
J. Retrofit-sprinkler piping cover system.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.
B. Section 099113 - Exterior Painting: Preparation and painting of exterior fire protection piping systems.
C. Section 099123 - Interior Painting: Preparation and painting of interior fire protection piping systems.
D. Section 210523 - General-Duty Valves for Water-Based Fire-Suppression Piping.
E. Section 210553 - Identification for Fire Suppression Piping and Equipment: Piping identification.
F. Section 211200 - Fire-Suppression Standpipes: Standpipe design.
G. Section 211300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.03 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
B. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
F. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
G. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.
H. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
I. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
J. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2022.
K. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

L. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.

M. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

O. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.

P. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.

Q. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2025.

R. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).

S. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.

T. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

U. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

V. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

W. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

X. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).

Y. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

Z. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.

AA. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.

BB. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).

CC. AWWA C606 - Grooved and Shouldered Joints; 2022.

DD. FM (AG) - FM Approval Guide; Current Edition.

EE. FM 1920 - Approval Standard for Pipe Couplings and Fittings for Aboveground Fire Protection Systems; 2007.

FF. ITS (DIR) - Directory of Listed Products; Current Edition.

GG. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

HH. UL (DIR) - Online Certifications Directory; Current Edition.

II. UL 213 - Rubber Gasketed Fittings for Fire-Protection Service; Current Edition, Including All Revisions.

JJ. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

KK. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

LL. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

D. Manufacturer's qualification statement.

E. Installer's qualification statement.

F. Project Record Documents: Record actual locations of components and tag numbering.

G. Operation and Maintenance Data: Include installation instructions and spare parts lists.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Valve Stem Packings: Two for each type and size of valve.

1.05 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified in this section.
   1. Minimum three years experience.

C. Valves: Bear FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

D. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

E. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary protective coating on cast iron and steel valves.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Sprinkler-based System:
   1. Comply with NFPA 13.
   2. See Section 211300.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A795 Schedule 40, black.
   1. Steel Fittings: ASME B16.5 steel flanges and fittings.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
   3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

B. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: AWWA C110/A21.10, standard thickness.
   2. Joints: AWWA C111/A21.11, SBR or vulcanized styrene-butadiene rubber gasket.
   3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.03 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch (25 mm) above finished floor.
   2. Provide sealant for watertight joint.
   3. Drilled Penetrations: Provide 1-1/2 inch (40 mm) angle ring or square set in silicone adhesive around penetration.

B. Plastic, Sheet Metal, or Moisture-Resistant Fiber: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

C. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) greater than external; pipe diameter.
   3. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.04 PIPE SLEEVE-SEAL SYSTEMS

A. Manufacturers:
   1. Advance Products & Systems, Inc; _____: www.apsonline.com/#sle.
   2. GPT, a company of Enpro Industries, Inc; _____: www.gptindustries.com/#sle.

B. Modular Mechanical Seals:
   1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
   2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
   3. Size and select seal component materials in accordance with service requirements.
   4. Service Requirements:
      a. Underground, buried, and wet conditions.
   5. Glass-reinforced plastic pressure end plates.

C. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.

D. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch (76.2 mm) thick.

E. Pipeline-Casing Seals:
   1. End Seals: 1/8 inch (3.1 mm), pull-on type, rubber or synthetic rubber based.

2.05 FIRE-RATED ENCLOSURES

A. Manufacturers:
   1. Fire Rated Product Specialties Corp; _____: www.frpsonline.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Provide as required to preserve fire resistance rating of building elements.

2.06 ESCUTCHEONS

A. Manufacturers:
   1. Fire Protection Products, Inc; _____: www.fppi.com/#sle.com/#sle.
   2. Tyco Fire Protection Products; _____: www.tyco-fire.com/#sle.
   3. Viking Group Inc; _____: www.vikinggroupinc.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Material:
   1. Chrome-plated.
   2. Grade TP304, seamless tube, ASTM A269/A269M stainless steel.
   3. Metals and Finish: Comply with ASME A112.18.1.

C. Construction:
   1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
   2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.07 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
   1. Manufacturers:
      a. AFCON, a brand of Anvil International; _____: www.anvilintl.com/#sle.
      b. FNW; _____: www.fnw.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.

B. Hangers for Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
   1. Manufacturers:
      a. AFCON, a brand of Anvil International; _____: www.anvilintl.com/#sle.
      b. FNW; _____: www.fnw.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   1. Manufacturers:
      a. Substitutions: See Section 016000 - Product Requirements.

D. Vertical Support: Steel riser clamp.
   1. Manufacturers:
      a. Anvil International; _____: www.anvilintl.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2.08 MECHANICAL COUPLINGS

A. Manufacturers:
   1. Anvil International; _____: www.anvilintl.com/#sle.
   2. Shurjoint Piping Products, Inc; _____: www.shurjoint.com/#sle.
   3. Tyco Fire Protection Products; ____: www.tyco-fire.com/#sle.

4. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Rigid Mechanical Couplings for Grooved Joints:
1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig (2065 kPa).
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

2.09 PIPING SPECIALTIES

A. Auxiliary Drains: Condensate collection drain for each section of trapped pipe in preaction or dry fire protection system.
1. Manufacturers:
a. AGF Manufacturing; _____: www.agfmfg.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Air Venting Valves:
1. Manufacturers:
a. AGF Manufacturing; _____: www.agfmfg.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

C. Test Connections:
1. Inspector's Test Connection for Preaction and Dry Pipe Systems:
a. Provide test connections approximately 6 feet (2 m) above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.
b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
c. Supply discharge orifice with same size as corresponding sprinkler orifice.
d. Limit vertical height of exterior wall penetration to 2 feet (0.61 m) above finished grade.
e. Manufacturers:
1) AGF Manufacturing; _____: www.agfmfg.com/#sle.

2.10 PRESSURE GAUGES

A. Manufacturers:
1. AGF Manufacturing: www.agfmfg.com/#sle.
2. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
3. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
4. Omega Engineering, Inc: www.omega.com/#sle.
5. Winters Instruments: www.winters.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Steel with brass bourdon tube.
2. Diameter: 4-1/2 inch (115 mm).
3. Mid-Scale Accuracy: One percent.
4. Scale: Display in psi and kPa.

2.11 RETROFIT-SPRINKLER PIPING COVER SYSTEM

A. Manufacturers:
   1. DecoShield Systems, Inc; _____: www.decoshield.com/#sle.

B. General Requirements:
   1. Surface Burning Characteristics: Flame spread index/smoke developed index of 20/250, maximum, when tested in accordance with ASTM E84 or UL 723.

C. Materials:
   1. Piping Cover System: Removal-resistant, modular, snap-fit cover units, clips, and anchors for use with CPVC, steel, and copper piping systems.
   2. Cover Units: L-shaped and U-shaped cross-section units of flame retardant resin material, paintable finish.
   3. Unit Length: 7.5 feet (2.29 m).
   4. Provide sidewall sprinkler head housing in compliance with NFPA 13.
   5. Provide coupling fittings for joining units end to end and prefabricated inside and outside corner fittings and end caps as required.
   6. Provide mounting clips to secure covers to wall-ceiling per manufacturer requirements.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 m).
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

G. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
   2. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   3. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
    a. Painting of interior fire suppression systems is specified in Section 099123.
    b. Painting of exterior fire suppression systems is specified in Section 099113.

H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

J. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. Aboveground Piping:
    a. Pack solid using mineral fiber complying with ASTM C592.
    b. Fill space with an elastomer caulk to a depth of 0.50 inch (15 mm) where penetrations occur between conditioned and unconditioned spaces.
2. All Rated Openings: Caulk tight with firestopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

K. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a watertight seal.
6. Install in accordance with manufacturer's recommendations.

L. Escutcheons:
1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

N. Die-cut threaded joints with full-cut, standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 210500

SECTION 210523
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Two-piece ball valves with indicators.

B. Iron butterfly valves with indicators.

C. Check valves.

D. Indicator posts.

E. Trim and drain valves.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 210553 - Identification for Fire Suppression Piping and Equipment.

C. Section 211100 - Facility Fire-Suppression Water-Service Piping.

D. Section 211300 - Fire-Suppression Sprinkler Systems.

E. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

F. Section 284600 - Fire Detection and Alarm.

1.03 ABBREVIATIONS AND ACRONYMS

A. EPDM: Ethylene-propylene diene monomer.

B. NRS: Non-rising stem.

C. OS&Y: Outside screw and yoke.

D. PTFE: Polytetrafluoroethylene.

1.04 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

C. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300; 2021.

D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.

E. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2024.

F. AWWA C606 - Grooved and Shouldered Joints; 2022.

G. FM (AG) - FM Approval Guide; Current Edition.

H. FM 1110 - Approval Standard for Indicator Posts; 1990.

I. FM 1112 - Examination Standard for Indicating Valves (Butterfly or Ball Type); 2020.

J. FM 1140 - Approval Standard for Quick Opening Valves 1/4 Inch through 2 Inch Nominal Size; 1998.

K. FM 1210 - Approval Standard for Swing Check Valves; 2004.

L. UL (DIR) - Online Certifications Directory; Current Edition.

M. UL 258 - Shutoff Valves for Trim and Drain Purposes for Fire Protection Service; Current Edition, Including All Revisions.

N. UL 262 - Gate Valves for Fire-Protection Service; Current Edition, Including All Revisions.

O. UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.

P. UL 789 - Indicator Posts for Fire-Protection Service; Current Edition, Including All Revisions.

Q. UL 1091 - Standard for Butterfly Valves for Fire-Protection Service; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least than ten years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

C. Where listed products are specified, provide products listed, certified, and labeled by FM (AG), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose indicated.

D. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect valve ends and flange faces.
   3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors and maintain at higher than ambient dew point temperature.
      b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Source Limitations: Furnish valves of same kind by same manufacturer.

B. Valve-End Connections:
   1. Flanges on Iron Valves: ASME B16.1 or ASME B16.42.
   2. Threaded Ends: ASME B1.20.1.
   3. Grooved Ends: AWWA C606.

C. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:
   1. Handwheel: For other than quarter-turn trim and drain valves.
   2. Hand-lever: For quarter-turn trim and drain valves 2 NPS (50 DN) and smaller.

2.02 TWO PIECE BALL VALVES WITH INDICATORS

A. Manufacturers:
   1. FNW: www.fnw.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. UL 1091 and FM 1112 listed.

C. Description:
   1. Minimum Pressure Rating: 175 psig (1200 kPa).
   2. Body Design: Two piece.
   3. Body Material: Forged brass or bronze.
   4. Port Size: Full or standard.
   5. Seat: PTFE.
   6. Stem: Bronze or stainless steel.
   7. Ball: Chrome-plated brass.
   8. Actuator: Worm gear or traveling nut.
   9. End Connections: Threaded or grooved.

2.03 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers:
   1. FNW: www.fnw.com/#sle.
   2. Kennedy Valve: www.kennedyvalve.com/#sle.
   3. Arita Valve, a Unimech brand; BF-28/29: www.unimechflow.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. UL 1091 and FM 1112 listed.

C. Minimum Pressure Rating: 175 psig (1200 kPa).

D. Body Material: Cast or ductile iron.

E. Seat: EPDM.

F. Stem: Stainless steel.

G. Disc: Ductile iron with EPDM coating.

H. Actuator: Worm gear or traveling nut.

I. Body Design: Grooved-end or wafer style.

2.04 SWING CHECK VALVES

A. Manufacturers:

1. FNW: www.fnw.com/#sle.
2. Kennedy Valve; AWWA Compliant: www.kennedyvalve.com/#sle.
3. Arita Valve, a Unimech brand; SW-55: www.unimechflow.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. UL 312 and FM 1210 listed.

C. Minimum Pressure Rating: 175 psig (1200 kPa).

D. Body Material: Cast or ductile iron.

E. Clapper: Bronze, EPDM-coated ductile iron, or stainless steel.

F. Seat: Bronze or EPDM-coated bronze.

G. End Connections: Flanged.

2.05 INDICATOR POSTS

A. Wall Indicator Posts:
1. Manufacturers:
a. Kennedy Valve: www.kennedyvalve.com/#sle.
b. Arita Valve, a Unimech brand; UIP-W38 Wall Indicator Post: www.unimechflow.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. UL 789 and FM 1110 listed, wall-mounted indicator post for operating sprinkler-system isolation valves located on opposite side of wall.
3. Body: Cast or ductile iron.
4. Operation: Lockable handwheel.
5. Finish: AWWA C550 epoxy coating.

2.06 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Manufacturers:
a. Mueller Streamline, Co; Series 7700: www.muellerstreamline.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
2. Description:
a. UL 258 or FM 1140 listed.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass or bronze.
e. Port Size: Full or standard.
f. Seat: PTFE.
g. Stem: Bronze or stainless steel.
h. Ball: Chrome-plated brass.
i. Actuator: Hand-lever.
j. End Connections: Threaded or grooved.

PART 3 EXECUTION

3.01 EXAMINATION

A. Confirm valve interior to be free of foreign matter and corrosion.

B. Remove packing materials.

C. Examine guides and seats by operating valves from the fully open position to the fully closed position.

D. Examine valve threads and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage.
   1. Check bolting for proper size, length, and material.
   2. Verify gasket for size, defects, damage, and suitable material composition for service.

F. Replace defective valves with new valves.

3.02 INSTALLATION

A. Install valves in accessible locations to allow for operation, inspections, tests, and maintenance.

B. Install listed valves in accordance with their listing.

C. Install valves in accordance with manufacturer's instructions.

D. Support valves independently of adjacent piping.

E. Install valves in horizontal piping with stem at or above pipe center.

F. Position valves to allow full actuator movement.

G. Install OS&Y valves with full clearance for rising stem. Install surrounding components so they do not interfere with nor are they impacted by full extension of rising stem.

H. Install supervised shutoff valves in supervised-open position.

I. Install permanent identification signs indicating portion of system controlled by each shutoff valve.

J. Install threaded-end valves with unions upstream and downstream.

K. Install valve tags. See Section 210553. Label valves in accordance with NFPA standard applying to the piping system in which valves are installed.

END OF SECTION 210523

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SECTION 211100
FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water pipe.

B. Valves.

C. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 055000 - Metal Fabrications.

C. Section 099123 - Interior Painting.

D. Section 210500 - Common Work Results for Fire Suppression.

E. Section 211300 - Fire-Suppression Sprinkler Systems.

F. Section 260583 - Wiring Connections.

1.03 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.

D. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

F. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

G. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).

H. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

I. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.

J. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2025.

K. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).

L. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; 2022.

M. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

N. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.

O. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.

P. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).

Q. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipe; 2020.

R. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.

S. AWWA M11 - Steel Pipe - A Guide for Design and Installation; 2017, with Addendum (2019).

T. FM (AG) - FM Approval Guide; Current Edition.

U. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

V. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

C. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturer's catalog information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Test Reports: Factory certified tests to verify that short-term rupture strength for RTRP I (filament bound) jointing is 1,500 psi (10.3 MPa) or greater.

F. Field Quality Control Submittals: Testing activities.

G. Project Record Documents:
   1. Record actual locations of piping mains, valves, connections, fire hydrants, free-standing fire department connections, underground manholes and vaults, valve boxes, thrust restraints, and invert elevations.

H. Maintenance Data: Include installation instructions, spare parts lists, and exploded assembly views.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Valve Repacking Kits: One for each type and size of valve.

1.05 QUALITY ASSURANCE

A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years documented experience.

D. Provide grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

E. Date stamp castings used for coupling housings, fittings, and valve bodies for quality assurance and traceability.

F. Coupling Manufacturer:

G. Welder Qualifications:
   1. Certify in accordance with ASME BPVC-IX.

H. Valves: Bearing product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

I. Products:
   1. Listed, classified, and labeled as suitable for the purpose specified and indicated.

J. Perform Work in accordance with local authorities having jurisdiction, municipality, and water utility requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 WATER PIPE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F. Provide standard weight, zinc-coated, and listed piping.
   1. Products:
      a. Wheatland Tube Company; _____: www.wheatland.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Fittings: Comply with ASME B16.3 Class 150, zinc-coated, threaded or ASME B16.4 Class 125, zinc-coated.
   3. Mechanically Factory Applied Protective Materials:
      a. Clean by wire brushing and solvent cleaning.
      b. Apply one coat of coal-tar primer and two coats of coal-tar enamel complying with AWWA C203.
      c. Protect threaded pipe ends and fittings prior to coating.

B. Ductile Iron Pipe: Listed, AWWA C104/A21.4:
   1. Fittings: Ductile iron, standard thickness.
   2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket with rods.
   3. Jackets: AWWA C105/A21.5 polyethylene jacket.

C. Ductile Iron Pipe: Listed, AWWA C151/A21.51.
   1. Fittings: AWWA C110/A21.10, ductile iron, standard thickness.
   2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR rubber gasket with 3/4 inch (19 mm) diameter rods.

2.02 VALVES

A. General:
   1. Manufacturer's name and pressure rating marked on valve body.
   2. Minimum Compliance: UL (DIR) listed and labeled.
   3. Maximum Inlet Pressure: 400 psi (2,760 kPa).
   4. Maximum Service Temperature: 180 degrees F (82.2 degrees C).
   5. Valve Coatings:
      a. Internally: 4 mils, 0.004 inch (0.10 mm) epoxy, minimum.

b. Externally: Epoxy base then fire red enamel paint or heat-fused red epoxy paint.

B. Deluge Valves:
1. Manufacturers:
a. Substitutions: See Section 016000 - Product Requirements.
2. Size: 3 inch NPS (80 mm, DN) to 8 inch NPS (200 mm, DN), Class 150 flange ends.
3. Type: Globe valve remotely activated using electric solenoid control valve and manual emergency override.
4. Function: Diaphragm actuated 2-position valve for supply into dry sprinkler pipes.
5. Construction:
a. Body: ASTM A536, ductile iron Grade 65-45-12.
b. Main Valve Seat Ring: ASTM B62, bronze.
c. Stem: Stainless steel.
d. Elastomers Diaphragms, Resilient Seats, and O-rings: Buna-N.
e. Pilot Control System: ASTM B62, bronze with stainless steel trim.

C. Gravity (Swing) Check Valve, Flanged End:
1. Manufacturers:
a. Apollo Valves; _____: www.apollovalves.com/#sle.
b. Kennedy Valve; _____: www.kennedyvalve.com/#sle.
c. Watts Water Technologies; _____: www.watts.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. 2-1/2 inch NPS (65 mm, DN) to 10 inch NPS (250 mm, DN):
a. Construction:
1) Body: Cast iron complying with ASTM A126, Class B.
2) Disc: ASTM A126 cast iron, ASTM A536 ductile iron, or ASTM B584 cast brass.
3) Replaceable seats and discs.
4) Maximum Working Pressure: 175 psi (1200 kPa).

D. Gravity (Swing) Check Valve, Grooved End:
1. Manufacturers:
a. Anvil International; _____: www.anvilintl.com/#sle.
b. Apollo Valves; _____: www.apollovalves.com/#sle.
c. Globe Fire Sprinkler Corporation; _____: www.globesprinkler.com/#sle.
d. Reliable Automatic Sprinkler Company, Inc; _____: www.reliablesprinkler.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. 2-1/2 inch NPS (65 mm, DN) to 6 inch NPS (150 mm, DN):
a. Construction:
1) Body: ASTM A48/A48M gray iron, ASTM A126 cast iron, or ASTM A536 cast iron.
2) Coatings (as applicable): Rust inhibiting orange enamel paint on exterior and interior surfaces.
3) Clapper:
(a) Material: Constructed of stainless steel or ductile iron.
(b) Facing: EPDM.
4) Seat: Constructed of stainless steel, brass, or bronze.
5) Spring: Stainless steel.
6) Hinge Pin: Stainless steel.
7) Maximum Working Pressure: 250 psi (1725 kPa).

2.03 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 033000.

B. Tracer Wire:
   1. Provide magnetic, detectable conductor with clear plastic covering and imprinted with "Water Service" in large letters.
   2. Conductor to be of sufficient length to be continuous over each separate run of nonmetallic pipe.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.03 INSTALLATION

A. General Requirements:
   1. Location of Water Lines:
      a. Terminate the work covered by this Section at a point approximately 5 feet (1.5 m) from the building unless indicated otherwise.
      b. Do not install water line closer horizontally than 10 feet (3 m) from any sewer line unless indicated otherwise.
   2. Sleeving:
      a. Sleeve water piping where piping is required to be installed within 3 feet (900 mm) of existing structures.
      b. Provide ductile iron or Schedule 40 steel sleeves.
      c. Fill annular space between pipe and sleeves with mastic.
      d. Install water pipe and sleeve without damaging structures or causing settlement or movement of foundations or footings.
   3. Pipe Laying and Jointing:
      a. Remove fins and burrs from pipe and fittings.
      b. Prior to placing in position, clean pipe, fittings, valves, and accessories, and maintain in clean condition.
      c. Provide proper facilities for lowering pipe sections into trenches.
      d. Dropping or dumping of piping, fittings, valves, or any other water line material into trenches is not permitted.
      e. Cut pipe in a neat, workmanlike manner accurately to length established at the site and work into place without forcing or springing.
      f. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material.
      g. Wedging or blocking between bells and spigots will not be permitted.
      h. Install bell-and-spigot pipe with the bell end pointing in the direction of laying.
      i. Grade the pipeline in straight lines avoiding the formation of dips and low points.
      j. Support piping at proper elevation and grade.
      k. Secure firm, uniform support.
      l. Wood support blocking will not be permitted.
      m. Install pipe so that the full length of each pipe section and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.

n. Provide anchors and supports where indicated and necessary for fastening work into place.
o. Provide proper provisions for expansion and contraction of pipelines.
p. Keep trenches free of water until joints have been properly made.
q. Close open ends of piping temporarily with wood blocks or bulkheads at the end of each workday.
r. Do not install pipe during unacceptable trench conditions or inclement weather.
s. Minimum Depth of Pipe Cover: Not less than 2-1/2 feet (760 mm).

4. Connections to Existing Water Lines:
   a. Ensure minimal interruption of service on the existing line.
   b. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.
5. Penetrations:
   a. Provide ductile-iron or Schedule 40 steel for pipes passing through walls of valve pits and structures.
   b. Fill annular space between sleeves and walls with rich cement mortar.
   c. Fill annular space between pipe and sleeves with mastic.
6. Flanged Pipe: Install only above grade or with the flanges in valve pits.

B. Special Requirements:
1. Ductile Iron Piping:
   a. Unless otherwise specified, install pipe and fittings in accordance with paragraph "General Requirements".
   b. Jointing:
      1) Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.
      2) Make flanged joints with the gaskets, bolts, and nuts specified for this type joint.
         (a) Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other accessories and equipment.
         (b) Align bolt holes for each flanged joint.
         (c) Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.
         (d) Do not allow adjoining flange faces to be out of parallel to such a degree that the flanged joint cannot be made watertight without over-straining the flange.
         (e) When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.
         (f) Use set-screwed flanges to make flanged joints where conditions prevent the use of full length, flanged pipe and assemble in accordance with the recommendations of the set-screwed flange manufacturer.
      3) Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.
      4) Make grooved and shouldered type joints with the couplings previously specified for this type joint connecting pipe with the grooved or shouldered ends specified for this type joint; assemble in accordance with the recommendations of the coupling manufacturer.

(a) Groove pipe in the field only with approved grooved cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.

5) Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint.
   (a) Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves be full size for the bolt holes.
   (b) Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.

c. Allowable Deflection:
   1) Maximum Allowable Deflection: As stated in AWWA C600.
   2) If the alignment requires deflection in excess of the above limitations, furnish special blends or a sufficient number of shorter pipe lengths to provide angular deflections within the limit set forth.

d. Pipe Anchorage:
   1) Provide concrete thrust blocks (reaction backing), for pipe anchorage except where metal harness is indicated.
   2) Thrust blocks to comply with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks to be as indicated.
   3) Use concrete, ASTM C94/C94M, having a minimum compressive strength of 2,500 psi (15 MPa) at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.
   4) Provide metal harness in accordance with the requirements of AWWA C600 for thrust restraint, using tie rods and clamps as indicated in NFPA 13, except as otherwise indicated.

e. Exterior Protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet, using Class A polyethylene film, in accordance with AWWA C105/A21.5.

2. Steel Piping:
   a. Jointing:
      1) Flanged:
         (a) Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other equipment and accessories.
         (b) Align bolt holes for each flanged joint.
         (c) Use full-size bolts for the bolt holes; use of undersized bolts due to misalignment of bolt holes or for any other purpose will not be allowed.
         (d) Do not allow adjoining flange faces to be out of parallel to such a degree that the flanged joint cannot be made water-tight without straining the flange.
         (e) When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it with one of correct dimensions.
      2) Grooved:
         (a) Make grooved type joints with the couplings specified for this type joint connecting pipe with roll-grooved ends or pipe with welded-on cut-grooved adapters, each with dimensions as previously specified for this type of joint.

(b) Groove pipe ends in the field only with approved groove rolling equipment and groove adapters in the field only with approved groove cutting equipment; use only groove rolling and groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings.
(c) Obtain approval for field-cut grooves prior to assembling the joint.

3) Shouldered: Make shouldered type joints with the couplings specified for this type joint connecting pipe with the shouldered ends specified for this type of joint.
4) Assemble grooved and shouldered type joints in accordance with the recommendations of the coupling manufacturer.

b. Allowable Offsets:
1) Form short-radius curves and closures by short lengths of pipe or fabricated specials specified.

c. Pipe Anchorage:
1) Provide concrete thrust blocks (reaction backing) for pipe anchorage, except where metal harness is indicated.
2) Thrust blocks to be in accordance with the recommendations for thrust restraint in AWWA M11, except that size and positioning of thrust blocks are to be as indicated.
3) Use ASTM C94/C94M concrete having a minimum compressive strength of 2500 psi (15 MPa) at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.
4) Metal Harness:
(a) Provide in accordance with the recommendations for joint harnesses in AWWA M11, except as otherwise indicated.
(b) Fabricated by the pipe manufacturer and furnished with the pipe.

C. Valves:
1. Set valves on solid bearing.
2. Center and plumb valve box over valve.
3. Set box cover flush with finished grade.

3.04 SERVICE CONNECTIONS

3.05 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
1. See Section 014000 - Quality Requirements for additional requirements.
2. Provide all labor, equipment, and incidentals required for field testing, except that water and electric power needed for field tests will be furnished as set forth in Section 015100 - Temporary Utilities.
3. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently and at least 5 days after placing of concrete.
4. Fill pipeline 24 hours before testing and apply test pressure to stabilize system, using only potable water.
5. Test water piping in accordance with NFPA 13, where the additional water added to the system must not exceed the limits given in NFPA 13.
6. Pressure test piping to ____ psi (____ kPa).
7. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
8. Prepare reports of testing activities.

3.06 CLEANING

A. Upon completion of the installation of water lines and appurtenances, remove and haul away all surplus material, including debris resulting from the work.

3.07 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

B. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Location: At project site.

END OF SECTION 211100

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SECTION 211300
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 210500 - Common Work Results for Fire Suppression: Pipe and fittings.

C. Section 210523 - General-Duty Valves for Water-Based Fire-Suppression Piping.

D. Section 210553 - Identification for Fire Suppression Piping and Equipment.

E. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

F. Section 284600 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; Current Edition.

B. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

C. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).

D. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

E. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

F. ITS (DIR) - Directory of Listed Products; Current Edition.

G. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
   3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.

D. Samples: Submit two of each style of sprinkler specified.

E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

F. Designer's qualification statement.

G. Installer's qualification statement.

H. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

J. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.05 QUALITY ASSURANCE

A. Maintain one copy of referenced design and installation standard on site.

B. Comply with FM (AG) requirements.

C. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Equipment and Components: Provide products that bear FM (AG) label or marking.

F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
   1. Anvil International; _____: www.anvilintl.com/#sle.
   2. Tyco Fire Protection Products; _____: www.tyco-fire.com/#sle.
   3. Viking Corporation; _____: www.vikinggroupinc.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.

B. Occupancy: Light hazard; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.

D. Interface system with building control system.

E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

F. Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
   2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
   3. Manufacturers:

a. AFCON, a brand of Anvil International; _____: www.anvilintl.com/#sle.
b. Powers Fasteners, Inc; _____ www.powers.com/#sle.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
4. Manufacturers:
a. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Exposed Area Type: Pendant type.
1. Response Type: Standard.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Escutcheon Plate Finish: Chrome plated.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

D. Storage Sprinklers: Pendant type with guard.
1. Response Type: Standard.
2. Coverage Type: Standard.
3. Finish: Chrome plated.
4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

E. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.
1. Finish: Brass.

F. Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
2. Include all supports and bracing.
3. Provide braided type tube as required for the application.
4. Manufacturers:
a. FlexHead Industries, a brand of Anvil International; _____: www.anvilintl.com/#sle.
b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
1. Test and drain valve.
2. Replaceable internal components without removing valve from installed position.
3. Manufacturers:
a. Victaulic Company; Series 751 with Series 760 motor alarm: www.victaulic.com/#sle.

b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Place pipe runs to minimize obstruction to other work.

D. Place piping in concealed spaces above finished ceilings.

E. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

G. Flush entire piping system of foreign matter.

H. Hydrostatically test entire system.

I. Require test be witnessed by Fire Marshal.

3.02 INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

3.03 SCHEDULES

A. System Hazard Areas:
   1. Offices: Light Hazard.
   2. Warehouse: Ordinary Hazard, Group 2.
   3. Computer Room: Light Hazard, Preaction.

B. Sprinklers:
   1. Drawing Code:
   2. Manufacturer:
   3. Model:
   4. Location:
   5. Temperature Rating:
   6. Finish:
   7. Style:

END OF SECTION 211300

SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

1.02 RELATED REQUIREMENTS

A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. NEMA MG 00001 - Motors and Generators; 2024.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

D. Operation Data: Include instructions for safe operating procedures.

E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group; _____: www.baldor.com/#sle.

B. Substitutions: See Section 016000 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Section 260583 for required electrical characteristics.

B. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.

C. Construction:
   1. Open drip-proof type except where specifically noted otherwise.

2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for shaft mounted fans, oil burners, and centrifugal pumps: Split phase type.

C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

D. Single phase motors for pumps: Capacitor start type.

E. Single phase motors for pumps: Capacitor start, capacitor run type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULES

A. NEMA Open Motor Service Factors.
   1. 1/6-1/3 hp:
      a. 3600 rpm: 1.35.
      b. 1800 rpm: 1.35.
   2. 1/2 hp:
      a. 1800 rpm: 1.25.

END OF SECTION 220513

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SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeve-seals.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 099113 - Exterior Painting: Preparation and painting of exterior piping systems.

C. Section 099123 - Interior Painting: Preparation and painting of interior piping systems.

D. Section 220523 - General-Duty Valves for Plumbing Piping.

E. Section 220553 - Identification for Plumbing Piping and Equipment: Piping identification.

F. Section 220716 - Plumbing Equipment Insulation.

G. Section 220719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

C. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified this section.
   1. Minimum three years experience.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE-SLEEVE SEALS

A. Manufacturers:
   1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
   2. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.
   3. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Modular Mechanical Sleeve-Seal:

1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
3. Size and select seal component materials in accordance with service requirements.
4. Service Requirements:
   a. Corrosion resistant.
   b. Oil, fuel, gas, and solvent resistant.
   c. Fire Resistant: 1 hour, UL (DIR) approved.
   d. High Temperature, up to 400 degrees F (204 degrees C).
5. Glass-reinforced plastic pressure end plates.

C. Sealing Compounds:
1. Provide packing and sealing compound to fill pipe to sleeve thickness.
2. Combined packing and sealing compounding to match partition fire-resistance hourly rating.

D. Pipe Sleeve Material:
1. Bearing Walls: Steel, cast iron, or terra-cotta pipe.
2. Masonry Structures: Sheet metal or fiber.

E. Wall Sleeve: PVC material with waterstop collar, and nailer end-caps.

F. Sleeve-Forming Disk: Non-conductive plastic-based material, 3 inch (76.2 mm) thick.

G. Pipeline-Casing Seals:
1. Coated boltless casing-spacer for 4 inch (100 mm) carrier pipe.
2. Coated boltless modular seal for 6 inch (150 mm) carrier pipe.
3. End Seals: 1/8 inch (3.1 mm), pull-on type, rubber or synthetic rubber based.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

E. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

C. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

END OF SECTION 220517

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SECTION 220519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gas meters.

B. Flow meters.

C. Pressure gauges.

D. Manometers.

E. Thermometers.

F. Pressure-temperature test plugs.

1.02 RELATED REQUIREMENTS

A. Section 232113 - Hydronic Piping.

B. Section 253516 - Integrated Automation Sensors and Transmitters.

1.03 REFERENCE STANDARDS

A. AGA/ANSI B109 Set - INCLUDES ANSI B109.1, ANSI B109.2, ANSI B109.3, ANSI B109.4; 2000.

B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.

C. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

D. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi; 2004 (Reaffirmed 2025).

E. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).

F. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

G. IEEE 802.3 - IEEE Standard for Ethernet; 2022 (Corrigendum 2024).

H. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

I. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Utility Service Metering: Coordinate and apply Utility Service Provider requirements in terms of meter type, size, physical location, pipe size, upstream/downstream pipe lengths required, and other installation details.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements. for additional provisions.

PART 2 PRODUCTS

2.01 GAS METERS

A. Diaphragm Gas Meters:
   1. Manufacturers:
      a. Elster American Meter; _____: www.elster-americanmeter.com/#sle.
      b. Itron, Inc; _____: www.itron.com/#sle.
      c. Norgas, Inc; _____: norgas.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Maximum Operating Line Pressure: 10 psi (0.7 bar).
   3. Gas Flow Rate: Propane with flow rate as indicated on drawings.
   4. Rangeability and Accuracy: 100 to 1 at plus or minus 1 percent.
   5. Temperature Compensation: -30 to 140 degrees F (-34 to 60 degrees C).
   6. B109.1/B109.2 of AGA/ANSI B109 Set, coated aluminum case with security seals, female threaded piping connection, and hermetically sealed register.
   7. Accessories: Provide downstream PT test plug and upstream pressure-regulating valve with vent.

2.02 FLOWMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
   2. McCrometer, Inc; _____: www.mccrometer.com/#sle.
   3. Omega Engineering a subsidiary of Spectris, Plc; _____: www.omega.com/#sle.
   4. VWR International, LLC; _____: us.vwr.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. In-Line Monitor:
   1. Material: Borosilicate glass.
   2. Accuracy: Plus or minus five percent full scale.
   3. Flow: Water, flow-range as indicated on drawings.
   4. Connection Size: 1 inch (25 mm, DN) NPT female.
   5. Maximum Service Pressure: 200 psi (13.8 bar).

2.03 PRESSURE GAUGES

A. Manufacturers:
   1. Ashcroft, Inc; _____: www.ashcroft.com/#sle.
   2. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
   3. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
   4. Omega Engineering a subsidiary of Spectris, Plc; [_____]: www.omega.com/#sle.
   5. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
   6. Winters Instruments; _____: www.winters.com/#sle.
   7. Substitutions: See Section 016000 - Product Requirements.

B. Bourdon Tube for Liquids and Gases:
   1. Dial Size and Cover: 4-1/2 inch (115 mm) diameter scale with polycarbonate window.
   2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
   3. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
   4. Process Connection: Lower-back, 1/4 inch (8 mm, DN) NPT male except where noted.
   5. Comply with UL 393 when used for fire protection service or UL 404 when used for compressed gas service.

2.04 THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
2. Moeller Instrument Company, Inc; _____: www.moellerinstrument.com/#sle.
3. Watts Water Technologies, Inc; _____: www.watts.com/#sle.
4. Weiss Instruments, LLC; _____: www.weissinstruments.com/#sle.
5. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
6. Winters Instruments; _____: www.winters.com/#sle.
7. Substitutions: See Section 016000 - Product Requirements.

B. General:
1. Product Compliance: ASTM E1.
2. Lens: Clear glass, except where stated.
3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

C. Thermometers - Dial Type:
1. Fixed: 5 inch (125 mm) diameter dial with black pointer, stainless steel case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch (63.5 mm) NPT stem.

2.05 PRESSURE-TEMPERATURE TEST PLUGS:

A. Manufacturers:
1. Watts Water Technologies, Inc; _____: www.watts.com/#sle.
2. Weiss Instruments, LLC; _____: www.weissinstruments.com/#sle.
3. Weksler Glass Thermometer Corp; _____: www.wekslerglass.com/#sle.
4. Winters Instruments; _____: www.winters.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Size: 500 psi (34.5 bar) capacity; 1/2 inch (13 mm) MPT brass fitting with gasket, cap, and retaining strap for 1/8 inch (3 mm) pressure gauge or temperature probe.

C. Wetted Materials per Temperature Range:
1. Up to 200 degrees F (93 degrees C): Brass probe with neoprene core.

D. Accessories: Brass, lever-handle cock and snubber-filter.

E. Test Kit: Internally padded carrying case fitted with two 2-1/2 inch (60 mm) diameter pressure gauges, adapters, two 1/8 inch (3 mm) probes, and 1 inch (25 mm) dual-scale dial thermometers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports, and test plugs.

3.02 INSTALLATION

A. Install metering products in accordance with manufacturer's instructions for intended fluid type and service.

B. Install gas meters in accordance with Utility Service Provider instructions with required appurtenances.

C. Install pressure gauges as follows:
1. At Pumps: Place single gauge before strainer, suction side and discharge side.
2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
3. Include siphons on high temperature systems and select type according to service rating.

4. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.

D. Install thermometers as follows:
   1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.
   2. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch (60 mm) to accommodate sockets. Ensure sockets are above insulation clearance.

E. Locate PT (pressure-temperature) test plugs adjacent to control device sockets.

END OF SECTION 220519

SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Angle valves.

B. Ball valves.

C. Check valves.

D. Gate valves.

E. Globe valves.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 083100 - Access Doors and Panels.

C. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Section 220553 - Identification for Plumbing Piping and Equipment.

E. Section 220719 - Plumbing Piping Insulation.

F. Section 221005 - Plumbing Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

A. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding; 2022.

B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.

G. ASME B31.9 - Building Services Piping; 2020.

H. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

I. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).

K. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).

L. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

M. MSS SP-45 - Drain and Bypass Connections; 2020.

N. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.

O. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

Q. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

R. NSF 61 - Drinking Water System Components - Health Effects; 2021.

S. NSF 372 - Drinking Water System Components - Lead Content; 2022.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
   1. See Section 016000 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball, butterfly, gate or plug.
   2. Throttling: Provide globe, angle, ball, or butterfly.
   3. Swing Check (Pump Outlet):
      a. 2 inch (50 mm, DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

E. High Pressure, Compressed Air Valves 150 psi (1035 kPa) to 200 psi (1380 kPa):
   1. 2 inch (50 mm, DN) and Smaller:
      a. Bronze: Provide with solder-joint ends.
      b. Ball: One piece, full port, brass with brass trim.
      c. Bronze Lift Check: Class 125, bronze disc.
      d. Bronze Swing Check: Class 125, bronze disc.
      e. Bronze Gate: Class 125, NRS.

F. Domestic, Hot and Cold Water Valves:
   1. 2 inch (50 mm, DN) and Smaller:
      a. Bronze and Brass: Provide with solder-joint ends.
      b. Bronze Angle: Class 125, bronze disc.
      c. Ball: One piece, full port, brass with brass trim.
      d. Bronze Swing Check: Class 125, bronze disc.
      e. Bronze Globe: Class 125, bronze disc.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:

D. Valve-End Connections:
   1. Threaded End Valves: ASME B1.20.1.
   2. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.
   3. Solder Joint Connections: ASME B16.18.

E. General ASME Compliance:
   1. Solder-joint Connections: ASME B16.18.
   2. Building Services Piping Valves: ASME B31.9.

F. Potable Water Use:
   1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
   2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, ANGLE VALVES

A. Class 125; CWP Rating: 200 psi (1380 kPa):
   1. Comply with MSS SP-80, Type 1.
   2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
   3. End Connections: Pipe thread.
   4. Stem: Bronze.
   5. Disc: Bronze.
   6. Packing: Asbestos free.
   7. Handwheel: Bronze or aluminum.

2.04 BRASS, BALL VALVES

A. One Piece, Full Port with Brass Trim and Push-to-fit or Threaded Connections:
   1. Comply with MSS SP-110.
   2. CWP Rating: 200 psi (1379 kPa).
   3. Body: Forged brass.
   4. Seats: PTFE.
   5. Stem: Brass.
   6. Ball: Chrome-plated brass.
   7. Operator: Handle.

2.05 BRONZE, BALL VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. One Piece, Reduced Port with Bronze Trim:
   1. Comply with MSS SP-110.
   2. WSP Rating: 400 psi (2760 kPa).
   3. CWP Rating: 600 psi (4140 kPa).
   4. Body: Bronze.
   5. End Connections: Pipe press.
   6. Seats: PTFE.

2.06 BRONZE, LIFT CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
   1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
   2. CWP Rating: 200 psi (1380 kPa).
   3. Design: Vertical flow.
   4. Body: Comply with ASTM B61 or ASTM B62, bronze.
   5. End Connections: Threaded.
   6. Disc (Type 1): Bronze.

2.07 BRONZE, SWING CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
   1. Pressure and Temperature Rating: MSS SP-80, Type 3.
   2. Design: Y-pattern, horizontal or vertical flow.
   3. WOG Rating: 200 psi (1380 kPa).
   4. Body: Bronze, ASTM B62.
   5. End Connections: Threaded.
   6. Disc: Bronze.

2.08 BRONZE, GATE VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

2.09 BRONZE, GLOBE VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125 and Class 250:
   1. Class 125:
      a. WOG Rating: 200 psi (1380 kPa).
      b. WSP Rating: 125 psi (861.8 kPa), saturated.
   2. Class 250: WOG Rating; 300 psi (2070 kPa).
   3. Comply with MSS SP-80, Type 1.
   4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
   5. End Connections: Threaded or solder.
   6. Bonnet: NRS; Non-rising Stem.
   7. Non-Rising Stem: Bronze.
   8. Disc: PTFE.
   9. Packing: Asbestos free.
   10. Handwheel Operator: Malleable iron.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION 220523

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prefabricated trapeze-framed systems.

B. Strut systems for pipe or equipment support.

C. Beam clamps.

D. Pipe hangers.

E. Pipe supports, guides, shields, and saddles.

F. Nonpenetrating rooftop supports for low-slope roofs.

G. Retrofit piping cover system.

H. Anchors and fasteners.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 055000 - Metal Fabrications.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.

D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

E. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

K. FM (AG) - FM Approval Guide; Current Edition.

L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

M. UL (DIR) - Online Certifications Directory; Current Edition.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
   1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

D. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

E. Fire Resistance: Provide hardware rated for 60 minutes resistance unless specifically indicated by the authority having jurisdiction.

F. Materials for Metal Fabricated Supports: Comply with Section 055000.
   1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
   2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

G. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.
   1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

2.02 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

A. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. Manufacturers:
      a. Anvil International, LLC: www.asc-es.com/#sle.
      b. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.
      c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
      e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. Strut Channel or Bracket Material:
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

2.03 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:
   1. Manufacturers:
      a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
      b. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
      d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:
   1. Threaded zinc-plated steel unless otherwise indicated.

2. Minimum Size, Unless Otherwise Indicated or Required:
    a. Equipment Supports: 1/2 inch (13 mm, DN) diameter.
    b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm, DN) diameter.
    c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm, DN) diameter.
    d. Trapeze Support for Multiple Pipes: 3/8 inch (10 mm) in length.

C. Channel Nuts:
1. Manufacturers:
    a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    b. FNW; 7821: www.fnw.com/#sle.
    c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.
    e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

D. Cable Hanging System Kits:
1. Manufacturers:
    a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    b. Ductmate Industries, Inc: ductmate.com/#sle.
    c. Gripple, Inc: www.gripple.com/#sle.
    d. _____.
    e. Substitutions: See Section 016000 - Product Requirements.
    f. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Provide cable-wire in bulk or pre-cut lengths with respective cable hangers as required to hold minimum weight of 120 lb (54.4 kg).
3. Accessories: Provide brackets, clip or c-clip hangers, covers, and y-hook hangers.

2.04 BEAM CLAMPS

A. Manufacturers:
1. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
2. FNW; 7201: www.fnw.com/#sle.
3. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.
5. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

B. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.

C. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.

D. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

E. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.

F. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.

G. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish.

H. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

I. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.05 PIPE HANGERS

A. Band Hangers, Adjustable:
   1. Manufacturers:
      a. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
      c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

B. Swivel Ring Hangers, Adjustable:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
      c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. MSS SP-58 type 10, epoxy-painted, zinc-colored.
   3. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   4. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
   5. Felt-Lined: Provide for uninsulated pipe to reduce noise and prevent static issues.

C. Clevis Hangers, Adjustable:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. FNW; 7005: www.fnw.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
   2. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
   3. Felt-Lined: MSS SP-58 type 1, zinc-plated, silicone-free carbon steel.
   4. Light-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
   5. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.

D. Nonmetallic Pipe Hangers:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. DecoShield Systems, Inc; Snap-2 Hangers: www.decoshield.com/#sle.
      c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. CPVC fabricated, snap-action hanger for pendant or sidewall applications.

2.06 PIPE CLAMPS

A. Riser Clamps:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. FNW; 7020: www.fnw.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
      d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
5. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
6. UL (DIR) listed: Pipe sizes 1/2 to 8 inch (15 to 200 mm, DN).

B. Strut Clamps:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7815: www.fnw.com/#sle.
c. Unistrut, a brand of Atkore International, Inc: www.unistrut.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

C. Insulation Coupling:
1. Manufacturers:
a. FNW; 7897: www.fnw.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Two bolt-type clamps designed for installation under insulation.
3. Material: Carbon steel with epoxy copper or zinc finish.

2.07 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Stanchions:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
4. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

C. U-Bolts:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. FNW; 7610: www.fnw.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2. MSS SP-58 type 24, carbon steel u-bolt for pipe support or anchoring.

D. Intermediate Anchors and Pipe Alignment Guides:
1. Manufacturers:
a. Anvil International, LLC: www.anvilintl.com/#sle.
b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Pipe Sizes 6 inch (150 mm, DN) and Smaller: Minimum clearance of 0.16 inch (4 mm).
3. Pipe Size 8 inch (200 mm, DN): 0.625 inch (16 mm) U-bolt with double nuts providing minimum clearance of 0.28 inch (7 mm).
4. Pipe Size 10 inch (250 mm, DN): 0.75 inch (19 mm) U-bolt.
5. Pipe Sizes 12 to 16 inch (300 to 400 mm, DN): 0.875 inch (24 mm) U-bolt.
6. Pipe Sizes 18 to 30 inches (450 to 750 mm. DN): 1 inch (25 mm) U-bolt.
7. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

E. Pipe Alignment Guides:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
d. The Metraflex Company; Style IV Spider Type Guide: www.metraflex.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
f. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Pipe Sizes 8 inch (200 mm, DN) and Smaller: Spider or sleeve type.
3. Pipe Sizes 10 inch (250 mm, DN) and Larger: Roller type.

F. Pipe Shields for Insulated Piping:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. FNW; 7753: www.fnw.com/#sle.
c. Gregory Industries, Inc: www.gregorycorp.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
3. General Construction and Requirements:
a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
b. Shields Material: UV-resistant polypropylene with glass fill.
c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch (321 mm).
d. Service Temperature: Minus 40 to 178 degrees F (Minus 40 to 81 degrees C).
e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

G. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2. Liquid Temperatures Up to 122 degrees F (50 degrees C):
    a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
    b. Support From Below: MSS SP-58 types 35 through 38.

H. Pipe Supports, Thermal Insulated:
1. Manufacturers:
    a. Buckaroos, Inc: www.buckaroos.com/#sle.
    b. Substitutions: See Section 016000 - Product Requirements.
2. General Requirements:
    a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
    b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
    c. Provide pipe supports for 1/2 to 30 inch (15 to 750 mm, DN) iron pipes.
    d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.
3. PVC Jacket:
    a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.
    b. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
    c. Maximum Service Temperature: 180 degrees F (82 degrees C).
    d. Moisture Vapor Transmission: 0.0071 perm inch (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
    e. Minimum Thickness: 60 mil, 0.06 inch (1.524 mm).
    f. Connections: Brush-on welding adhesive.
4. Products:
    a. Buckaroos, Inc; CoolDry: www.buckaroos.com/#sle.
    b. Substitutions: See Section 016000 - Product Requirements.

I. Copper Pipe Supports:
1. Manufacturers:
    a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    b. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
    c. Substitutions: See Section 016000 - Product Requirements.
    d. Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by single manufacturer.

J. Overhead Pipe Supports:
1. Manufacturers:
    a. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
    b. Substitutions: See Section 016000 - Product Requirements.
    c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2.08 RETROFIT PIPING COVER SYSTEM

A. Manufacturers:
1. DecoShield Systems, Inc: www.decoshield.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. General Requirements:
1. Surface Burning Characteristics: Flame spread index/smoke developed index of 20/250, maximum, when tested in accordance with ASTM E84 or UL 723.

C. Materials:
   1. Piping Cover System: Removal-resistant, modular, snap-fit cover units, clips, and anchors for use with CPVC, steel, and copper piping systems.
   2. Cover Units: L-shaped and U-shaped cross-section units of flame retardant resin material, paintable finish.
   3. Unit Length: 7.5 feet (2.29 m).
   4. Provide coupling fittings for joining units end to end and prefabricated inside and outside corner fittings and end caps as required.
   5. Provide mounting clips to secure covers to wall-ceiling per manufacturer requirements.

2.09 ANCHORS AND FASTENERS

A. Manufacturers - Mechanical Anchors:
   1. FNW; 7502: www.fnw.com/#sle.
   2. Hilti, Inc: www.us.hilti.com/#sle.
   3. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
   4. Powers Fasteners, Inc: www.powers.com/#sle.
   5. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   6. Substitutions: See Section 016000 - Product Requirements.

B. Manufacturers - Powder-Actuated Fastening Systems:
   1. Hilti, Inc: www.us.hilti.com/#sle.
   2. Powers Fasteners, Inc: www.powers.com/#sle.
   3. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

C. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

D. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

E. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

F. Hollow Masonry: Use toggle bolts.

G. Hollow Stud Walls: Use toggle bolts.

H. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

I. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.

J. Sheet Metal: Use sheet metal screws.

K. Wood: Use wood screws.

L. Plastic and lead anchors are not permitted.

M. Preset Concrete Inserts: Continuous metal strut channel and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   1. Channel Material: Use galvanized steel.
   2. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm) minimum base metal thickness.
   3. Manufacturer: Same as manufacturer of metal strut channel framing system.

N. Concrete Inserts:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation; _____: www.eaton.com/#sle.

b. HoldRite, a brand of Reliance Worldwide Corporation; _____: www.holdrite.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

H. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

J. Secure fasteners according to manufacturer's recommended torque settings.

K. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 220529

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SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 2 PRODUCTS

1.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Pipe Markers: 3/4 inch (20 mm) diameter and higher.

1.02 PIPE MARKERS

END OF SECTION 220553

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SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cellular glass insulation.

B. Glass fiber insulation.

C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 099123 - Interior Painting: Painting insulation jacket.

C. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.

E. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.

F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).

G. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

J. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth; 2016b.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER INSULATION

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Johns Manville Corporation: www.jm.com/#sle.
   3. Knauf Insulation: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; FIBERGLAS Pipe Insulation ASJ: www.owenscorning.com/en-us/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   2. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. Maximum Service Temperature: 220 degrees F (104 degrees C).
   2. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm (0.029 ng/(Pa s m)).

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
   2. Blanket: 1.0 pcf (16 kg/cu m) density.
   3. Weave: 5 by 5.

H. Indoor Vapor Barrier Finish:
   1. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Insulating Cement: ASTM C449.

2.03 CELLULAR GLASS INSULATION

A. Manufacturers:
   1. Owens Corning Corporation; FOAMGLAS: www.owenscorning.com/en-us/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C552, Type II, Grade 6.
   1. K (Ksi) Value: 0.35 (0.050) at 100 degrees F (38 degrees C).
   2. Service Temperature Range: From 250 degrees F (121 degrees C) to 800 degrees F (427 degrees C).
   3. Water Vapor Permeability: 0.005 perm inch (0.007 ng/(Pa s m)) maximum per inch.
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 JACKETING AND ACCESSORIES

A. PVC Plastic Jacket:
   1. Manufacturers:
      a. Johns Manville Corporation: www.jm.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F (Minus 18 degrees C).
      b. Maximum Service Temperature: 150 degrees F (66 degrees C).
      c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil, 0.010 inch (0.25 mm).
      e. Connections: Brush on welding adhesive.
   3. Covering Adhesive Mastic: Compatible with insulation.

B. Reinforced Tape:
   1. Manufacturers:
      a. Ideal Tape Co., Inc: www.idealtape.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
   3. Comply with UL 723 or ASTM E84.
   4. Moisture Vapor Permeability: 0.00 perm inch (0.00 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
   5. Finish: Match insulation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

E. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

G. Inserts and Shields:
1. Application: Piping 1-1/2 inches (40 mm) diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078400.

I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with canvas jacket sized for finish painting.

3.03 SCHEDULES

A. Plumbing Systems:
1. Domestic Hot Water Supply:
a. Cellular Melamine Foam Insulation:
b. Glass Fiber Insulation:
2. Domestic Hot Water Recirculation:
a. Glass Fiber Insulation:
1) Pipe Size Range: All sizes.

END OF SECTION 220719

SECTION 221005
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary waste piping, above grade.
B. Chemical-resistant sanitary waste piping.
C. Domestic water piping, above grade.
D. Natural gas piping, above grade.
E. Pipe flanges, unions, and couplings.
F. Pipe hangers and supports.
G. Pipe sleeve-seal systems.
H. Ball valves.
I. Flow-balancing valves.

1.02 RELATED REQUIREMENTS

A. Section 083100 - Access Doors and Panels.
B. Section 099123 - Interior Painting.
C. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.
D. Section 330110.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

A. ANSI LC 1/CSA 6.26 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2019.
B. ANSI Z223.1 - National Fuel Gas Code; 2024.
C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
G. ASME B31.1 - Power Piping; 2022.
H. ASME B31.3 - Process Piping; 2022.
I. ASME B31.9 - Building Services Piping; 2020.
J. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
L. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.
N. ASTM B32 - Standard Specification for Solder Metal; 2020.
O. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2020.

P. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

Q. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

R. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

S. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

T. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

U. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

V. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

W. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.

X. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

Y. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2019a.

Z. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.

AA. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

BB. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2021.

CC. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40; 2023.

DD. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2024.

EE. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2023.

FF. ASTM F442/F442M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR); 2023.

GG. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.

HH. AWWA C651 - Disinfecting Water Mains; 2014, with Addendum (2020).

II. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

JJ. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 1989.

KK. IAPMO IGC 361 - Continuous Flexible Self-Plunging Waste Pipes; 2019.

LL. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

MM. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

NN. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

OO. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

PP. NSF 61 - Drinking Water System Components - Health Effects; 2021.

QQ. NSF 372 - Drinking Water System Components - Lead Content; 2022.

RR. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.

D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, ABOVE GRADE

A. Continuous Flexible Self-Plunging Waste Pipes: IAPMO IGC 361, provide to connect lavatories and sink tail piece to PVC sanitary waste piping.

B. CPVC Pipe: ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M.
   1. Fittings: CPVC; ASTM D2846/D2846M, ASTM F437, ASTM F438, or ASTM F439.
   2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.

C. PVC Pipe: ASTM D2729.

1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 CHEMICAL-RESISTANT SANITARY WASTE PIPING

A. PP Pipe: Polypropylene, flame retardant.
   1. Fittings: Polypropylene.
   2. Joints: Electrical resistance fusion.
   3. Manufacturers:
      a. IPEX USA, LLC; _____: www.ipexna.com/#sle.

B. Couplings:
   1. No-Hub Couplings:
      a. Testing: In accordance with ASTM C1277 and CISPI 310.
      b. Gasket Material: Neoprene complying with ASTM C564.
      c. Band Material: Stainless steel.
      d. Eyelet Material: Stainless steel.
   2. Shielded, Heavy Duty No-Hub Couplings:
      a. Testing: In accordance with ASTM C1540 and FM 1680.
      b. Gasket Material: Neoprene complying with ASTM C564.
      c. Band Material: Stainless steel.
      d. Eyelet Material: Stainless steel.
      e. Manufacturers:

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Manufacturers:
      a. Anvil International: www.anvilintl.com/#sle.
      b. Apollo Valves: www.apollovalves.com/#sle.
      c. FNW; Copper Press: www.fnw.com/#sle.
      d. Grinnell Products: www.grinnell.com/#sle.

2.05 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

B. Flexible Gas Piping:
   1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
   2. Comply with ASTM E84.
   3. Fittings: Provided by piping system manufacturer.
   4. Provide piping with integral lightning protection.
   5. Manufacturers:
      a. Omega Flex, Inc; TracPipe CounterStrike: www.omegaflex.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2.06 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch (80 mm, DN) and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch (25 mm, DN):

1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

2.07 PIPE HANGERS AND SUPPORTS

A. See Section 220529 for additional requirements.

B. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.
   5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
   6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High-density polypropylene.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment and Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
      e. Height: Provide minimum clearance of 6 inches (150 mm) under pipe to top of roofing.
      f. Manufacturers:
         1) PHP Systems/Design: www.phpsd.com/#sle.
         2) Substitutions: See Section 016000 - Product Requirements.

C. Plumbing Piping - Drain, Waste, and Vent:
   1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Malleable iron, adjustable swivel, split ring.
   2. Hangers for Pipe Sizes 2 inch (50 mm, DN) and Over: Carbon steel, adjustable, clevis.
   3. Wall Support for Pipe Sizes to 3 inch (80 mm, DN): Cast iron hook.
   4. Wall Support for Pipe Sizes 4 inch (100 mm, DN) and Over: Welded steel bracket and wrought steel clamp.
   5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Plumbing Piping - Water:
   1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Malleable iron, adjustable swivel, split ring.
   2. Hangers for Cold Pipe Sizes 2 inch (50 mm, DN) and Over: Carbon steel, adjustable, clevis.
   3. Hangers for Hot Pipe Sizes 2 to 4 inch (50 to 100 mm, DN): Carbon steel, adjustable, clevis.
   4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Concrete Wedge Expansion Anchors: Comply with ICC-ES AC193.

2. Masonry Wedge Expansion Anchors: Comply with ICC-ES AC01.
3. Other Types: As required.

2.08 PIPE SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. BMW Company; _____: www.bmwcompany.com/#sle.
2. GPT, a company of Enpro Industries, Inc; _____: www.gptindustries.com/#sle.
3. The Metraflex Company; MetraSeal: www.metraflex.com/#sle.

B. Modular Mechanical Seals:
1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
3. Size and select seal component materials in accordance to service requirements.
4. Glass reinforced plastic pressure end plates.

C. Wall Sleeve: PVC material with water-stop collar, and nailer end-caps.

D. Sleeve-Forming Disk: Non-conductive plastic-based material, 3 inch (76.2 mm) thick.

2.09 BALL VALVES

A. Manufacturers:
1. Anvil International: www.anvilintl.com/#sle.
2. Apollo Valves: www.apollovalves.com/#sle.
3. Grinnell Products: www.grinnell.com/#sle.
4. Nibco, Inc: www.nibco.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Construction, 4 inch (100 mm, DN) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.10 FLOW-BALANCING VALVES

A. Manufacturers:
1. Anvil International: www.anvilintl.com/#sle.
2. Griswold Controls: www.griswoldcontrols.com/#sle.
3. ITT Bell & Gossett: www.bellgossett.com/#sle.
4. Taco, Inc; _____: www.taco-hvac.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 083100.

H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

I. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
   1. See Section 099123 for painting of interior plumbing systems and components.

J. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

K. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

L. Sleeve pipes passing through partitions, walls, and floors.

M. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

N. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
   4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.

O. Pipe Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a watertight seal.

6. Install in accordance with manufacturer's recommendations.

P. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install globe valves for throttling, bypass, or manual flow control services.

E. Provide flow controls in water recirculating systems where indicated.

3.05 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Domestic Water Systems:
   1. Perform hydrostatic testing for leakage prior to system disinfection.
   2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
   3. General:
      a. Fill the system with water and raise static head to 10 psi (345 kPa) above service pressure. Minimum static head of 50 to 150 psi (345 to 1,034 kPa). As an exception, certain codes allow a maximum static pressure of 80 psi (551.6 kPa).

C. Gas Distribution Systems:
   1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
   2. General Systems:
      a. Inject a minimum of 10 psi (68.9 kPa) of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.
      b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound (0.45 kg).
   3. Welded Pipes or Systems with Service Pressures Above 14 in-wc (3.48 kPa):
      a. Inject a minimum of 60 psi (413.7 kPa) of compressed air into the piping system for a duration of 30 minutes and verify with a gauge that no perceptible pressure drop is measured.
      b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound (0.45 kg) with 1 psi (6.9 kPa) increments.

D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 330110.58.

B. Prior to starting work, verify system is complete, flushed, and clean.

C. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

D. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

F. Maintain disinfectant in system for 24 hours.

G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

3.08 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inch (15 mm, DN) to 1-1/4 inch (32 mm, DN):
         1) Maximum Hanger Spacing: 6.5 ft (2 m).
         2) Hanger Rod Diameter: 3/8 inches (9 mm).
      b. Pipe Size: 1-1/2 inch (40 mm, DN) to 2 inch (50 mm, DN):
         1) Maximum Hanger Spacing: 10 ft (3 m).
         2) Hanger Rod Diameter: 3/8 inch (9 mm).
      c. Pipe Size: 2-1/2 inch (65 mm, DN) to 3 inch (80 mm, DN):
         1) Maximum Hanger Spacing: 10 ft (3 m).
         2) Hanger Rod Diameter: 1/2 inch (13 mm).

END OF SECTION 221005

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SECTION 221006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Fixture stop-valve outlet boxes.
F. Backflow preventers.
G. Double check valve assemblies.
H. Water hammer arrestors.
I. Sumps.
J. Mixing valves.
K. Air vents.
L. Catch basins and manholes.

1.02 RELATED REQUIREMENTS

A. Section 016000 - Product Requirements: Procedures for Owner-supplied products.
B. Section 033000 - Cast-in-Place Concrete: Manhole bottoms.
C. Section 033000 - Cast-in-Place Concrete: Execution requirements for concrete catch basin bases.
D. Section 221005 - Plumbing Piping.
E. Section 223000 - Plumbing Equipment.
F. Section 224000 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.
C. ASME A112.6.3 - Floor Drains; 2022.
D. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
F. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2021.
G. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies; 2021.
H. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations; 2017 (Reaffirmed 2021).
I. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.

J. ASSE 1048 - Performance Requirements for Double Check Detector Backflow Prevention Assemblies; 2021e.

K. ASSE 1069 - Performance Requirements for Automatic Temperature Control Mixing Valves; 2020.

L. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.

M. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.

N. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

P. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2020.

Q. ASTM F1267 - Standard Specification for Metal, Expanded, Steel; 2018 (Reapproved 2023).

R. LonMark Interoperability Guide - LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4; 2005.

S. Modbus (PS) - The Modbus Organization Communications Protocol.; Latest Update.

T. NSF 61 - Drinking Water System Components - Health Effects; 2021.

U. NSF 372 - Drinking Water System Components - Lead Content; 2022.

V. PDI-WH 201 - Water Hammer Arresters; 2017.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

E. Manufacturer's qualification statement.

F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

G. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Loose Keys for Outside Hose Bibbs: One.
   3. Extra Hose End Vacuum Breakers for Hose Bibbs: One.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

A. Manufacturers:
   1. Josam Company; _____: www.josam.com/#sle.
   2. MIFAB, Inc; _____: www.mifab.com/#sle.
   3. Substitutions: See Section 016000 - Product Requirements.

B. Floor Drains:
   1. Manufacturers:
      a. Dallas Specialty & Mfg Co; _____: www.dallasspecialty.com/#sle.
      b. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
      c. MIFAB, Inc; FS1100-C Series: www.mifab.com/#sle.
      d. Zurn Industries, LLC; Z415-BZ1: www.zurn.com/#sle.
      e. Watts, Inc.: https://www.watts.com/.
      f. Substitutions: See Section 016000 - Product Requirements.

C. Floor Drain (FD-1):
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

D. Floor Drain (FD-2):
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel bronze strainer with removable perforated sediment bucket.

E. Floor Drain (FD-3):
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze funnel or anti-splash rim.

F. Floor Sink (FS-1):
   1. Lacquered cast iron body with dome strainer and seepage flange.
   2. Manufacturers:
      a. MIFAB, Inc; FS1720-FL Series: www.mifab.com/#sle.
      b. Watts, Inc.: https://www.watts.com/.
      c. Substitutions: See Section 016000 - Product Requirements.

2.03 CLEANOUTS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   2. Josam Company; _____: www.josam.com/#sle.
   3. MIFAB, Inc; C1100-R: www.mifab.com/#sle.
   4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
   5. Watts, Inc.: https://www.watts.com/.
   6. Substitutions: See Section 016000 - Product Requirements.

B. Cleanouts at Exterior Surfaced Areas (CO-1):
   1. Round cast nickel bronze access frame and non-skid cover.

C. Cleanouts at Interior Finished Floor Areas (CO-3):
   1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

D. Cleanouts at Interior Finished Wall Areas (CO-4):

1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

2.04 HOSE BIBBS

A. Manufacturers:
   1. Effebi; Sky: www.effebi.com/#sle.
   2. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   3. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
   4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
   5. Watts, Inc.: https://www.watts.com/.
   6. Substitutions: See Section 016000 - Product Requirements.

B. Interior Hose Bibbs:
   1. Bronze or brass with mounting flange, replaceable seat, hose thread spout, and integral or add-on vacuum breaker complying with ASSE 1011.
   2. Finishes:
      a. Exposed Locations: Polished chrome.
      b. Mechanical and Equipment Rooms: Polished chrome or rough bronze.
      c. Service Areas: Polished chrome.
   3. Operation:
      a. Exposed Locations: Operating key.
      b. Mechanical and Equipment Rooms: Handwheel, T-handle, or lever.
      c. Service Areas: Operating key.

C. Interior Mixing Type Hose Bibbs:
   1. Bronze or brass, hot- and cold- water wall-faucet with mounting flange, replaceable seats, hose thread spout, integral checks, handwheels, and vacuum breaker complying with ASSE 1011.
   2. Finishes:
      a. Exposed Locations: Polished chrome.
      b. Mechanical and Equipment Rooms: Rough bronze.
      c. Service Areas: Polished chrome.

2.05 FIXTURE STOP-VALVE OUTLET BOXES

A. Manufacturers:
   1. HoldRite, a brand of Reliance Worldwide Corporation; HR-F Series Fixture Outlet Box: www.holdrite.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

B. Description: Preformed plastic rough-in plate with round mini-box and single chrome-plated brass quarter-turn ball valve.

C. Provide fire-rated outlet-fitting assembly for installation in 1- and 2-hour rated walls.

D. Accessories:
   1. Support brackets for installation between framing studs.
   2. Water-supply piping tailpiece.
   3. Escutcheon in white primer finish.

2.06 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Apollo Valves: www.apollovalves.com/#sle.
   2. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com/#sle.
   3. MIFAB, Inc; BEECO Backflow Preventers: www.mifab.com/#sle.

4. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Reduced Pressure Backflow Preventer Assembly:
1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
2. Size: 3/4 to 2 inch (20 to 50 mm, DN) assembly with threaded gate valves.
3. Maximum Working Parameters: 175 psi (1,207 kPa) at 180 degrees F (82.2 degrees C).
4. Accessories: Provide air gap fitting, lead-free Y-strainer, and test cocks.

2.07 DOUBLE CHECK-VALVE ASSEMBLIES

A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
2. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com/#sle.
3. MIFAB, Inc; BEECO Backflow Preventers: www.mifab.com/#sle.
4. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com/#sle.
5. Zurn Industries, LLC; 350AST: www.zurn.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Double Check Valve Assembly:
1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
2. Size: 3/4 to 2 inch, NPS (20 to 50 mm, DN) assembly with threaded full port ball valves.
3. Maximum Working Parameters: 175 psi (1,207 kPa) at 180 degrees F (82.2 degrees C).
4. Accessories: Provide lead-free Y-strainer and pit-mounted protective enclosure.

2.08 WATER HAMMER ARRESTORS

A. Manufacturers:
1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
2. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
3. Watts Regulator Company, a part of Watts Water Technologies; _____: www.wattsregulator.com/#sle.
4. Zurn Industries, LLC; _____: www.zurn.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Water Hammer Arrestors:
1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F (minus 73 to 149 degrees C) and maximum 250 psi (1700 kPa) working pressure.

2.09 SUMPS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
2. Zurn Industries, LLC; _____: www.zurn.com/#sle.
3. Zoeller Pump Company: https://zoellerpumps.com/.
4. Substitutions: See Section 016000 - Product Requirements.

B. Epoxy coated fabricated steel with required openings and drainage fittings.

C. Cover: 3/8 inch (9 mm) thick checkered steel plate with gasket seal frames and anchor bolts.

2.10 MIXING VALVES

A. Thermostatic Master Mixing Valves:
   1. Manufacturers:
      a. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com/#sle.
      b. Leonard Valve Company: www.leonardvalve.com/#sle.
      c. Watts Water Technologies; POWERS: www.watts.com/#sle.
      d. Webstone, a NIBCO INC brand: www.nibco.com/#sle.
   2. Valve: ASSE 1017, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment.
   3. Finish: Rough bronze.
   4. Accessories:
      a. Strainer stop checks on inlets.
      b. Shut-off valve on outlet.
      c. Stem thermometer on outlet.
   5. Cabinet: 16 gauge, 0.0598 inch (1.52 mm) prime-coated steel, for recessed mounting with keyed lock.

B. Automatic Temperature Control Mixing Valves:
   1. Manufacturers:
      a. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
      b. Leonard Valve Company; _____: www.leonardvalve.com/#sle.
      c. Watts Water Technologies; POWERS; _____: www.watts.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Valve: ASSE 1069, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment; integral check valves with strainer screens on inlets.
   3. Accessories:
      a. Shut-off valve on outlet.
      b. Stem thermometer on outlet.
   4. Cabinet: 16 gauge, 0.0598 inch (1.52 mm) prime-coated steel, for recessed mounting with keyed lock.

C. Water Temperature Limiting Valves:
   1. Manufacturers:
      a. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
      b. Leonard Valve Company; _____: www.leonardvalve.com/#sle.
      c. Watts Water Technologies; POWERS; _____: www.watts.com/#sle.
      d. Webstone, a NIBCO INC brand: www.nibco.com/#sle.
      e. Substitutions: See Section 016000 - Product Requirements.
   2. Valve: ASSE 1070, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment with high-temperature limit stop; integral check valves with strainer screens on inlets.

2.11 AIR VENTS

A. Manufacturers:
   1. Cash Acme, a brand of Reliance Worldwide Corporation; _____: www.cashacme.com/#sle.
   2. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.

3. Taco, Inc; _____: www.taco-hvac.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:
1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.12 CATCH BASINS AND MANHOLES

A. Manufacturers:
1. Forterra; _____: www.forterrapressurepipe.com/#sle.
2. Kistner Concrete Products, Inc; _____: www.kistner.com/#sle.
3. Sherman Dixie Concrete Industries; _____: www.shermandixie.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Catch Basins:
1. Barrel: ASTM C478/C478M; precast concrete sections laid on cast-in-place reinforced concrete foundation pad, 36 inches (900 mm) or 48 inches (1200 mm) diameter with precast concrete top.
2. Inlet Assembly: Two piece heavy duty cast steel or cast iron frame and grate with ground or machined grate and frame bearing surfaces.
3. Standard: Round frame and grate:
a. Capacity 194 cu ft/s (5.5 cu m/s).
4. Slope bottom slab 10 percent to outlet invert.

C. Manholes: Formed-bottom type, laid on cast-in-place reinforced concrete foundation pad, see Section 033000.
1. Construction: Concrete masonry units.
2. Size: 48 inch (1200 mm) diameter.
3. Cover: Standard cast iron with minimum sized pick hole, and frame. Use heavy duty cover and frame in vehicular traffic areas.
4. Manufacturers:
a. Campbell Group; _____: www.campbellfoundry.com/#sle.
b. Neenah Enterprises, Inc; _____: www.nfco.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
5. Steps: 3/4 inch (19 mm) diameter galvanized steel on 16 inch (400 mm) centers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks.

H. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch (20 mm) minimum, and minimum 18 inches (450 mm) long.

END OF SECTION 221006

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 2 PRODUCTS

END OF SECTION 221319

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SECTION 221429
SUMP PUMPS

PART 2 PRODUCTS

END OF SECTION 221429

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SECTION 221500
GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and fittings.

B. Unions and couplings.

C. Air outlets.

1.02 RELATED REQUIREMENTS

A. Section 220523 - General-Duty Valves for Plumbing Piping.

B. Section 220553 - Identification for Plumbing Piping and Equipment.

C. Section 260583 - Wiring Connections.

1.03 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2018.

E. ASME B31.1 - Power Piping; 2022.

F. ASME B31.3 - Process Piping; 2022.

G. ASME B31.9 - Building Services Piping; 2020.

H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.

J. ASTM B32 - Standard Specification for Solder Metal; 2020.

K. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

D. Certificates: Provide certificate of compliance from Authority Having Jurisdiction indicating approval of air receiver.

E. Test Reports: Submit inspector's certificate for air receiver for inclusion in Operating and Maintenance Manuals.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

G. Project Record Documents: Record actual locations of equipment and components. Modify shop drawings to indicate final locations.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors, refrigerated air dryer on site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Grade B, Type E, Schedule 40 black.
   1. Manufacturers:
      a. Wheatland Tube Company: www.wheatland.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
   2. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   3. Joints: Threaded or welded to ASME B31.1.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, solder, Grade Sn95.

C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), annealed.
   1. Joints: Mechanically pressed.

2.02 UNIONS AND COUPLINGS

A. Unions:
   1. Ferrous Pipe: 150 psi (1034 kPa) malleable iron threaded unions.
   2. Copper Tube and Pipe: 150 psi (1034 kPa) bronze unions with soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.03 AIR OUTLETS

A. Quick Connector: 3/8 inch (10 mm) brass, snap-on connector with self closing valve, Style A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install valved drip connections at low points of piping system. See Section 220523.

C. Install takeoffs to outlets from top of main, with shut off valve after takeoff. Slope takeoff piping to outlets.

D. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

E. Identify piping system and components. See Section 220553.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.

C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.

D. Cap and seal ends of piping when not connected to mechanical equipment.

END OF SECTION 221500

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SECTION 223000
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial electric water heaters.

1.02 RELATED REQUIREMENTS

A. Section 251500 - Integrated Automation Software.

B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

C. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

E. NSF 61 - Drinking Water System Components - Health Effects; 2021.

F. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.

G. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Provide electrical characteristics and connection requirements.

C. Shop Drawings:
   1. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

D. Project Record Documents: Record actual locations of components.

E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

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

B. Certifications:
   1. Water Heaters: NSF approved.
   2. Electric Water Heaters: UL listed and labeled to UL 174.
   3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 5-year manufacturer warranty for domestic water heaters. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Manufacturers:
   1. A.O. Smith Water Products Co; _____: www.hotwater.com/#sle.
   2. Bradford White Corporation; _____: www.bradfordwhite.com/#sle.
   3. Rheem Manufacturing Company; _____: www.rheem.com/#sle.
   4. Lochinvar, Inc.: https://www.lochinvar.com/en_US/commercial/boilers/.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Commercial Electric Water Heaters:
   1. Manufacturers:
      a. Bradford White Corporation; ElectriFLEX Series: www.bradfordwhite.com/#sle.
      b. https://www.lochinvar.com/en_US/commercial/boilers/.
      c. Rheem.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Type: Factory-assembled and wired, electric, vertical storage.
   3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
   4. Performance:
   5. Electrical Characteristics:
   6. Tank: Glass lined welded steel; 4 inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
   7. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F (16 to 82 degrees C), flanged or screw-in nichrome elements, high temperature limit thermostat.
   8. Accessories:
      a. Water Connections: Brass.
      b. Dip Tube: Brass.
      c. Drain valve.
      d. Anode: Magnesium.
      e. Temperature and Pressure Relief Valve: ASME labeled.
   9. Tank: Welded steel ASME labeled pressure vessel; glass lining, mounted on steel channel base with lifting lugs, insulated with 2 inch (50 mm) glass fiber; enclosed with 16 gauge, 0.0598 inch (1.52 mm) steel jacket; baked enamel finish.

10. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.
11. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in (11.6 W/sq m).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Electrical Work: Provide automatic control and protective devices with associated wiring to interconnect related interfaced devices required for specified operation.

C. Coordinate system, equipment, and piping work with applicable electrical, fuel, gas, vent, drain, and waste support interconnections as included or provided by other trades.

D. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

END OF SECTION 223000

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SECTION 226000
GAS AND VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, tube, and fittings.
B. Valves.
C. Regulators and flowmeters.
D. Manifolds.
E. Outlets.
F. Vacuum pumps.
G. Alarm systems.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.
B. Section 078400 - Firestopping.
C. Section 220517 - Sleeves and Sleeve Seals for Plumbing Piping.
D. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.
E. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
F. Section 220553 - Identification for Plumbing Piping and Equipment.
G. Section 251500 - Integrated Automation Software.
H. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.
I. Section 312316 - Excavation.
J. Section 312323 - Fill.

1.03 ABBREVIATIONS AND ACRONYMS

A. CC: Cubic centimeters per minute.
B. CGA: Compressed Gas Association.
C. WAGD: Waste anesthesia gas disposal.

1.04 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
C. ASME B16.50 - Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings; 2021.
D. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.
E. ASME B31.3 - Process Piping; 2022.
F. ASME BPVC - Boiler and Pressure Vessel Code; 2023.
G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.

H. ASSE/IAPMO/ANSI 6015 - Bulk Medical Gas/Croygenic Fluid Central Supply Systems Installers; 2021.

I. ASSE/IAPMO/ANSI 6035 - Bulk Medical Gas/Cryogenic Fluid Central Supply Systems Verifiers; 2021.

J. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2025.

K. ASTM A403/A403M - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings; 2025.

L. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

M. ASTM B32 - Standard Specification for Solder Metal; 2020.

N. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

P. ASTM B103/B103M - Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar; 2019.

Q. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2020.

R. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems; 2019.

S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

T. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

U. AWS B2.2/B2.2M - Specification for Brazing Procedure and Performance Qualification; 2016.

V. CGA G-4.1 - Cleaning of Equipment for Oxygen Service; 2018.

W. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

X. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

Y. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

Z. NFPA 55 - Compressed Gases and Cryogenic Fluids Code; 2023, with Amendment .

AA. NFPA 99 - Health Care Facilities Code; 2024, with Errata.

BB. UL (DIR) - Online Certifications Directory; Current Edition.

CC. UL 1365 - Outline of Investigation for Corrugated Medical Tubing (CMT) Systems; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's literature and data sheets for each product. Include capacities, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
   1. Include sound level data for the following:
      a. Vacuum pumps.

C. Shop Drawings: Provide for products listed below. Indicate general assembly of components, mounting and installation details, unit dimensions, required clearances, construction details, field piping connection details, and electrical characteristics and connection requirements.
   1. Vacuum pumps.

D. Independent Inspection, Testing, and Verification Agency Reports: Documentation of inspection, testing, and verification results showing system compliance with NFPA 99.
   1. Submit copies to Owner.

E. Manufacturer's Instructions: Provide for products listed below. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
   1. Vacuum pumps.

F. Manufacturer's qualifications statement.

G. Operation and Maintenance Data: For each product, provide manufacturers installation, operating, testing, and maintenance instructions.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Complete set of floor plans showing actual installed locations of components, equipment, tanks, cylinders, piping, and valving. See Section 017800 for additional requirements.

1.06 QUALITY ASSURANCE

A. Laboratory Gas Systems: Select products and execute work in compliance with NFPA 99.

B. Laboratory Gas Systems: Select products and execute work in compliance with NFPA 55.

C. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
   1. Brazing: Qualified in accordance with ASME BPVC-IX or AWS B2.2/B2.2M.
   2. Bulk Medical Gas and Cryogenic Fluid Central Supply Systems: Certified in accordance with ASSE/IAPMO/ANSI 6015.

D. Testing and Verification Qualifications: Company specializing in performing testing of type specified in this section, with minimum five years of documented experience.
   1. Bulk Medical Gas and Cryogenic Fluid Central Supply Verifiers: Certified in accordance with ASSE/IAPMO/ANSI 6035.

E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept material on-site in factory containers and packing. Inspect for damage.

B. Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for _____. Complete forms in Owner's name and register with manufacturer.

C. Installer Warranty: Provide 2-year warranty for _____ commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA

A. Laboratory:
   1. Laboratory Air: 50 to 55 psig (345 to 380 kPa) operating pressure.
   2. Laboratory Nitrogen: 160 to 185 psig (1100 to 1275 kPa) operating pressure.
   3. Laboratory Oxygen: 50 to 55 psig (345 to 380 kPa) operating pressure.
   4. Laboratory Vacuum: 15 in-Hg (380 mm-Hg).

2.02 PIPE, TUBE, AND FITTINGS

A. Laboratory Gases:
   1. General Requirements:
      a. Pipe, tube, and fittings cleaned by manufacturer in accordance with CGA G-4.1.
      b. Pipe ends and tube ends factory capped or plugged by manufacturer prior to shipping and kept sealed until time of installation.
      c. Fittings sealed and labeled prior to shipping and kept sealed until time of installation.
   2. Copper Pipe:
      a. ASTM B819, seamless, drawn, Type L, factory labeled with nomenclature and colors complying with NFPA 99
         1) For nitrogen and instrument air systems with operating pressures in excess of 185 psig (1275 kPa) and with pipe sizes NPS 3 (DN80) and larger, use Type K.
         2) Manufacturers:
            (a) Mueller Streamline, Co: www.muellerstreamline.com/#sle.
            (b) Substitutions: See Section 016000 - Product Requirements.
      b. Fittings: Wrought copper, ASME B16.22 or ASME B16.50.
      c. Joints: Brazed, AWS A5.8M/A5.8, copper-phosphorus or copper-phosphorus-silver brazing filler.

B. Laboratory Gases:
   1. General Requirements:
      a. Piping cleaned by manufacturer with pipe ends and tube ends factory capped or plugged by manufacturer prior to shipping and kept sealed until time of installation.
      b. General Purpose piping shall be brazed copper tubing. For high purity laboratory gasses, use orbitally welded 316L stainless steel.
   2. Copper Pipe:
      a. ASTM B819, seamless, drawn, Type L.
         1) For nitrogen and laboratory air systems with operating pressures in excess of 185 psig (1275 kPa) and with pipe sizes NPS 3 (DN80) and larger, use Type K.
         2) Manufacturers:
            (a) Mueller Streamline, Co: www.muellerstreamline.com/#sle.
            (b) Substitutions: See Section 016000 - Product Requirements.
      b. ASTM B280, seamless, drawn, Type ACR.
      c. Brazed Fittings and Joints:
         1) Fittings: Wrought copper, ASME B16.22 or ASME B16.50.
         2) Joints: Brazed, AWS A5.8M/A5.8, copper-phosphorus or copper-phosphorus-silver brazing filler.

C. High Purity Laboratory Gas Conveyance Systems:
   1. Stainless Steel Pipe:
      a. Reference Codes: ASME B31.3, NFPA 55
      b. ASTM B280, seamless, drawn, Type ACR.
      c. ASTM A269/A213, seamless, drawn, AISI 316L Stainless Steel Tubing.

d. Joints: orbitally welded or mechanical flared compression

2. Stainless Steel tubing and fittings:
   a. Manufacturers:
      1) Beacon Medaes,: .
      2) Swagelok,: https://www.swagelok.com/.
      3) Substitutions: See Section 016000 - Product Requirements.
   b. Description: Manufactured assembly complying with requirements of NFPA 99 and listed as complying with UL 1365 consisting of copper corrugated medical tubing sheathed in fire-retardant jacket.
   c. Copper Tubing: ASTM B103/B103M, copper alloy UNS C51000.
   d. Maximum Operating Pressure: 185 psig (1275 kPa).
   e. Maximum Operating Temperature: 250 degrees F (120 degrees C).
   f. Jacketing: Low-density polyethylene, plenum rated, with maximum flame spread index of 25 and smoke development index of 50 when tested in accordance with ASTM E84.
   g. Fittings: Provided by piping system manufacturer, 316L stainless steel or equivalent.

D. Laboratory Vacuum:
   1. Copper Pipe:
      a. ASTM B819, seamless, drawn, Type L.
      b. ASTM B88/ASTM B88M seamless, drawn, Type L (Type B).
      c. Brazed Fittings and Joints:
         1) Fittings: Wrought copper, ASME B16.22 or ASME B16.50.
         2) Joints: Brazed, AWS A5.8M/A5.8, copper-phosphorus or copper-phosphorus-silver brazing filler.

2.03 VALVES

A. Manufacturers:
   1. Amico Corporation: www.amico.com/#sle.
   2. BeaconMedaes: www.beaconmedaes.com/#sle.
   3. Tri-Tech Medical: www.tri-techmedical.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. General Requirements for Valves for Laboratory Gas Systems:
   1. Manufacturer cleaned in accordance with CGA G-4.1.
   2. Sealed, bagged, and labeled prior to shipping in accordance with CGA G-4.1 and kept bagged and sealed until the time of installation.

C. Ball Valves:
   1. Manufacturers:
      a. Allied Healthcare Products, Inc; _____: www.alliedmedicalllc.com/#sle.
      b. NOVAIR USA: www.novair-usa.com/#sle.
      c. Tri-Tech Medical; _____: www.tri-techmedical.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Three-piece, bronze body, MSS SP-110, double-seal, with quarter-turn handle and replaceable neoprene or teflon seat and stem seals, 600 psi (4140 kPa) cold working pressure.

D. Check Valves:
   1. Manufacturers:
      a. Tri-Tech Medical: www.tri-techmedical.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2. Brass or bronze body, three piece, spring loaded, in-line removable and serviceable, 300 psi (2070 kPa) cold working pressure.
3. Check Valves for _____ Gas Systems: Provide manufacturer-installed ASTM B819 Type K copper extensions with threaded purge ports on upstream and downstream sides of valve.

E. Pressure Relief Valves:
1. Brass, bronze, or stainless steel body, direct-acting spring relief; select valve seats appropriate to gas system type; select relief settings to suit system components and operating pressures.

2.04 REGULATORS AND FLOWMETERS

A. General Requirements for Pressure Regulators and Flowmeters for Medical and Laboratory Gas Systems:
1. Manufacturer cleaned in accordance with CGA G-4.1.
2. Sealed, bagged, and labeled prior to shipping in accordance with CGA G-4.1 and kept bagged and sealed until the time of installation.

B. Single Stage Gas Pressure Regulators:
1. Manufacturers:
a. Amico Corporation; _____: www.amico.com/#sle.
b. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
c. Harris Products Group; _____: www.harrisproductsgroup.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Spring loaded, diaphragm type with manual pressure-adjustment knob.
a. Provide with wall mounting bracket.
3. Body: Brass.
4. Gas purity: High purity, grade 5.0.
5. Application: Cylinder regulator.
6. Delivery-Pressure Range: Select to suit gas being regulated.
a. Argon: 0 to 50 psig (0 to 345 kPa).
b. Carbon Dioxide: 0 to 50 psig (0 to 345 kPa).
c. Hydrogen: 0 to 50 psig (0 to 345 kPa).
d. Nitrogen: 0 to 200 psig (0 to 1380 kPa).
e. Oxygen: 0 to 50 psig (0 to 345 kPa).
7. Maximum Inlet Pressure to Regulator: 3,000 psig (21 MPa).
8. Delivery Pressure Gauge: Dual scale, 2-inch (50 mm) diameter.
9. Inlet Pressure Gauge: Dual scale, 2-inch (50 mm) diameter.
10. Products:
a. Harris Products Group; Model HP 721, single stage, brass, cylinder regulator: www.harrisproductsgroup.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

C. Dual Stage Gas Pressure Regulators:
1. Manufacturers:
a. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
b. Harris Products Group; _____: www.harrisproductsgroup.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Dual spring, dual diaphragm type with factory preset first-stage pressure and manually adjustable second-stage delivery pressure.
3. Body: Brass.

4. Application: Cylinder regulator.
5. Gas purity: General purpose, grade 4.0.
6. Delivery-Pressure Range: Select to suit gas being regulated.
   a. Argon: 0 to 50 psig (0 to 345 kPa).
   b. Carbon Dioxide: 0 to 50 psig (0 to 345 kPa).
   c. Hydrogen: 0 to 50 psig (0 to 345 kPa).
   d. Nitrogen: 0 to 200 psig (0 to 1380 kPa).
   e. Oxygen: 0 to 50 psig (0 to 345 kPa).
7. Maximum Inlet Pressure to Regulator: 3,000 psig (21 MPa).
8. Delivery Pressure Gauge: Dual scale, 2-inch (50 mm) diameter.
9. Inlet Pressure Gauge: Dual scale, 2-inch (50 mm) diameter.
10. Products:
    a. Harris Products Group; Model HP 722, dual stage, brass, cylinder regulator: www.harrisproductsgroup.com/#sle.
    b. Substitutions: See Section 016000 - Product Requirements.

2.05 MANIFOLDS

A. Duplex, Automatic Manifolds for Medical Gases:
   1. Manufacturers:
      a. Allied Healthcare Products, Inc; _____: www.alliedmedicalllc.com/#sle.
      b. Amico Corporation; _____: www.amico.com/#sle.
      c. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
      d. Harris Products Group; Model 764 DataSMART: www.harrisproductsgroup.com/#sle.
      e. Tri-Tech Medical; _____: www.tri-techmedical.com/#sle.
      f. Substitutions: See Section 016000 - Product Requirements.
   2. Description: Cabinet mounted, microprocessor controlled, automatic switchover, automatic reset, duplex manifold to automatically changeover from primary to secondary cylinder banks and allow replacement of depleted cylinders with no change in line pressure.
   3. Manifold:
      a. Constructed in accordance with NFPA 99.
      b. Cleaned in accordance with CGA G-4.1.
      c. Bank pressure regulators.
      d. Redundant line-pressure regulators.
      e. Pressure transducers.
      f. Internal relief valves piped to common vent port.
      g. Isolation valve on outlet.
   4. Headers:
      a. Constructed in accordance with NFPA 99.
      b. Cleaned in accordance with CGA G-4.1.
      c. Header isolation valves.
      d. Gas-specific cylinder pigtails.
      e. Arrange headers to have half of cylinders in service and half in reserve.
   5. Cabinet:
      a. NEMA EN 10250, Type 1, lockable, with baked enamel finish.
      b. Front-mounted analog or digital gauges indicating right bank pressure, left bank pressure, and outlet line pressure.
   6. Controls:
      a. Microprocessor-based to monitor cylinder pressures and initiate switchovers.

b. Indicator lights for each cylinder bank to show in use, ready, and empty.
c. Economizer mode for liquid cylinders.
d. Ethernet connection for remote monitoring, control, and data collection.
e. Dry contacts for remote alarm annunciation.
f. Alarms:
1) Switchover alarm or reserve-bank-in-use alarm.
2) High line pressure.
3) Low line pressure.

B. Automatic Manifolds for Specialty Laboratory Gases:
1. Manufacturers:
a. BeaconMedaes: www.beaconmedaes.com/#sle.
b. Harris Products Group; Model 763 DataSMART: www.harrisproductsgroup.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Description: Cabinet mounted, microprocessor controlled, automatic switchover, automatic reset, manifold to automatically changeover from primary to secondary cylinder banks and allow replacement of depleted cylinders with no change in line pressure.
3. Manifold:
a. Fabrication: Brass.
b. Cleaned in accordance with CGA G-4.1.
c. Bank pressure regulators.
d. Line-pressure regulator.
e. Pressure transducer.
f. Internal relief valves piped to common vent port.
g. Isolation valve on outlet.
4. Headers:
a. Cleaned in accordance with CGA G-4.1.
b. Header isolation valves.
c. Gas-specific cylinder pigtails.
5. Cabinet:
a. NEMA EN 10250, Type 1, lockable, with baked enamel finish.
b. Front-mounted analog or digital gauges indicating right bank pressure, left bank pressure, and outlet line pressure.
6. Controls:
a. Microprocessor-based to monitor cylinder pressures and initiate switchovers.
b. Indicator lights for each cylinder bank to show in use, ready, and empty.
c. Economizer mode for liquid cylinders.
d. Dry contacts for remote alarm annunciation.
e. Audible alarm with manual reset.
f. Alarms:
1) Switchover alarm or reserve-bank-in-use alarm.
2) High line pressure.
3) Low line pressure.

2.06 OUTLETS

A. Outlet Units:
1. Manufacturers:
a. Allied Healthcare Products, Inc; _____: www.alliedmedicalllc.com/#sle.
b. Amico Corporation; _____: www.amico.com/#sle.

c. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
d. NOVAIR USA: www.novair-usa.com/#sle.
e. Tri-Tech Medical; _____: www.tri-techmedical.com/#sle.
f. Water-Saver.
g. Substitutions: See Section 016000 - Product Requirements.

B. Faceplates:
1. Flush Outlets: Mount in galvanized steel boxes with stainless steel faceplate with polycarbonate cover, color coded with embossed labeling.
2. Surface Outlets: Surface mount with color coded plastic cover and stainless steel faceplate with polycarbonate cover, color coded with embossed labeling.

2.07 VACUUM PUMPS

A. Manufacturers:
1. Amico Corporation; _____: www.amico.com/#sle.
2. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
3. Becker Pumps Corporation: www.beckerpumps.com/#sle.
4. NOVAIR USA: www.novair-usa.com/#sle.
5. Tri-Tech Medical; _____: www.tri-techmedical.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Duplex Vacuum Pumps:
1. Type: Oilless claw, with VFD.
2. Type: Dry rotary vane.
3. Type: Lubricated rotary vane.
4. Description: Packaged assembly; factory wired, piped, and tested; consisting of electrically driven air-cooled vacuum pumps, intake filters, receiver, accessories, and controls.
5. Vacuum Pumps: Factory equip each vacuum pump with motor, inlet filter, isolation valve, check valve, vibration isolators, inlet and outlet flexible connectors, and temperature and pressure safety switches.
6. Receiver: Vertical, welded steel ASME receiver, prime coated with epoxy lining, with gauge and tank drain.
7. Duplex Controller: Prewired in NEMA EN 10250 Type 12 enclosure with fusible disconnects, magnetic motor starters with overload protection, control circuit transformers, clock timer, pressure switches, visual and audible alarms, hand-off-automatic selector switches, and safety disconnect door.
a. Electronic Touchscreen Controller:
1) Include built-in logic to track usage, optimize load, and diagnose system.
2) BAS, SCADA, or other Integrated Automation Link: BACnet MS/TP in accordance with ASHRAE Std 135.
3) Indicators:
(a) Vacuum level.
(b) Air intake filter loading.
(c) Cycle counter and hour meter for each vacuum pump.
(d) Alarms.

2.08 ALARM SYSTEMS

A. Manufacturers:
1. Allied Healthcare Products, Inc; _____: www.alliedmedicalllc.com/#sle.
2. Amico Corporation; _____: www.amico.com/#sle.

3. BeaconMedaes; _____: www.beaconmedaes.com/#sle.
4. NOVAIR USA: www.novair-usa.com/#sle.
5. Tri-Tech Medical; _____: www.tri-techmedical.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. High-Low Pressure Alarm Panel:
1. Closed circuit, self-monitoring type to monitor single gas such as oxygen, vacuum, compressed air, nitrous oxide, or nitrogen.
2. Green light for system normal.
3. High or low pressure warning:
a. Green light extinguishes.
b. Audible warning device sounds.
c. Red light energizes.
4. Gauge indicates pressure or vacuum.
5. Switch silences warning device.
6. Test switch to test light bulbs and audible warning device.
7. Provide system with internal switches, gauge, control unit, and transformer.

C. Digital Gas Pressure Monitor:
1. Type: Display-module with hardwired pressure sensor.
2. Base Module Interface:
a. Numeric display with alarm buzzer.
b. Self-test, silence, and programming controls.
c. Up to six digital numeric-display modules.
3. LED-based alarm level indicator, low to normal, and high.
4. Pressure Modules with Externally Wired Sensors:
a. Carbon dioxide.
b. Argon
c. Nitrogen.
d. Oxygen.
e. Vacuum.
5. Communications: RS-485.
6. Accessories: Backbox, power supply, and color-coded labels per gas type with units.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install laboratory gas systems in accordance with NFPA 55.

B. Install products and equipment in accordance with manufacturer's instructions.

C. Pipe, Tube, and Fittings:
1. Install piping parallel and perpendicular to walls. Install without springing or forcing.
2. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Extend 2 inches (50 mm) above finished floors. See Section 220517.
3. Make changes in size with reducing fittings.
4. Make changes in direction or required turns or offsets with fittings.
5. Cut pipe and tubing accurately and squarely.
6. Ream pipe and tube ends. Remove burrs.
7. Remove scale and dirt from outside of piping before assembly.
8. Braze joints in pipe and tubing in accordance with AWS B2.2/B2.2M. Continuously purge piping with oil-free, dry nitrogen during brazing.

9. Install exposed piping in wall-mounted sheet steel raceways and junction boxes.

D. Pipe Hangers and Supports:
   1. See Section 220529. Install in accordance with MSS SP-58.
   2. Medical Gases: Space hangers and support vertical piping in accordance with NFPA 99.
   3. Corrugated Medical Tubing: Support in accordance with manufacturer's instructions.

E. Piping Identification:
   1. Identify piping with tape and decals. See Section 220553.
   2. Install labeling on pipe at intervals of not more than 20 feet (6 m) and at least once in each room and each story traversed by pipeline.
   3. Medical Gas Systems: Label and color code piping in accordance with NFPA 99.

F. Valves:
   1. Install isolation valves at connections to equipment.
   2. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

G. Compressors, Vacuum Pumps, WAGD Vacuum Pumps, and Oral Evacuation Pumps:
   1. Vibration and Noise Isolation: See Section 220548.
   2. Install compressors and vacuum pumps on concrete housekeeping pad. See Section 033000.
   3. Install isolation valves at connections to equipment.
   4. Isolate systems including receivers, dryers, and filters until after completion and approval of purity tests for compressed air system. Tie-in at flange or union joint.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Laboratory Gas Systems: Engage independent agency to perform tests and inspections. Submit documentation of inspection and testing results.

C. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.

D. Pressure test laboratory gas systems in accordance with ASME B31.3.

E. Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adaptors.

F. Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

3.03 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals for closeout submittals.

B. See Section 017900 - Demonstration and Training for additional requirements.

C. Train operating personnel in operation and maintenance of the following:
   1. Vacuum pumps.
   2. Alarm systems.

D. Provide services of manufacturer's field representative to conduct training.

END OF SECTION 226000

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SECTION 226319
HIGH PURITY GAS PIPING SYSTEMS

SECTION 226319

HIGH PURITY GAS PIPING SYSTEMS

2.01 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2020.

B. ASME B46.1 - Surface Texture (Surface Roughness, Waviness and Lay); 2019.

C. ASTM - F3404-23; Standard Specification for Sheet Vinyl Floor Covering with Backing.

D. ASTM A479/A479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels; 2025.

E. ASTM A632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service; 2019 (Reapproved 2025).

F. ASTM F3404-23 - Standard Specification for Heterogeneous Polyurethane Tile or Plank Flooring; 2023.

G. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals; 2019.

2.02 RELATED DOCUMENTS

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

2.03 SUMMARY

A. Extent of high purity gas piping system work, is indicated on Drawings and schedules, and by requirements of this Section.

2.04 SUBMITTALS

A. General:
   1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data:
   1. Submit manufacturer's technical product data, installation instructions and cleaning procedures for high purity gas piping systems materials and products.

C. Shop Drawings:
   1. Submit Drawings of high purity gas pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Indicate interface and spatial relationship between piping and proximate equipment.

D. Wiring Diagrams:
   1. Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

E. Maintenance Data:
   1. Submit maintenance data and parts lists for high purity gas piping systems materials and products. Include this data, product data, shop drawings, record drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division-1.

F. Record Drawings:

1. At project closeout, submit record drawings of installed high purity piping systems in accordance with requirements of Division 1.

2.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver high purity gas piping systems equipment, including gas cabinets, and gas monitoring systems with factory-installed shipping skids; accessories packaged in factory-fabricated fiberboard containers; and pipe/tube and fittings with plastic end-cap protectors and sealed plastic bags to prevent pipe-end damage and to eliminate dirt and moisture from entering interior of pipe/tube.

B. Handle high purity gas piping and equipment carefully to avoid damage to components, enclosures and finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

C. Store high purity gas piping and equipment indoors and protect from weather and construction traffic.

D. High purity, ultra-high purity and contained ultra high purity pipe, tubing and fittings shall be delivered to the job site with capped ends, double bagged sealed and a low pressure charge of filtered inert gas. All pipe and fittings shall be stored in class 10,000 or better clean room environment. No pipe or fittings shall be delivered to the job site until the Contractor supplied portable clean room is constructed and operational.

2.06 REFERENCED DOCUMENTS

A. ASTM A269: Standard Specifications for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

B. ASTM A213/A213M: Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.

C. ASTM A632: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service.

D. ASTM A262: Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels, Practice E.

E. ASTM A270: Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing.

F. ASTM A450/A450M: Standard Specification for General Requirements for Carbon, Ferritic, and Austenitic Alloy Steel Tubes.

G. ASTM A479/A479M: Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

H. ANSI B46.1: Specification for Surface Texture - Surface Roughness, Waviness, and Lay.

I. MIL-STD-105E: Sampling Procedures and Tables for Inspection by Attributes.

J. FED-STD-209D: Federal Standard for Clean Room and Work Station Requirements, Controlled Environment.

K. SEMASPEC 9012041B-STD: Test Method for SEM Analysis of Metallic Surface Condition for Gas Distribution System Components.

L. SEMASPEC 90120403B-STD: Test Method for XPS Analysis of Surface Composition and Chemistry of Electropolished Stainless Steel Tubing for Gas Distribution System Components.

M. SEMASPEC 91060573B-STD: Test Method Auger Electron Spectroscopy (AES) Analysis of Surface and Oxide Composition of Electropolished Stainless Steel Tubing for Gas Distribution System Components.

2.07 QUALITY ASSURANCE

A. Installer Qualifications: Firm with at least 5 years of successful installation experience on projects with high purity gas piping systems work similar to that required for project. Provide references upon request. Only skilled craftsmen shall be used.

B. Codes and Standards:
   1. ASME Compliance: Fabricate and install laboratory supply piping systems in accordance with ASME B31.9 "Building Services Piping".
   2. Construct service fittings in accordance with SAMA LF6 "Laboratory and Hospital Service Fittings".
   3. CGA Compliance: Fabricate and install compressed gas handling systems in accordance with CGA Standards (Compressed Gas Association).
   4. UL Compliance: Provide electrical components which are UL listed and have UL label affixed.

C. The Owner or his designated representative will provide the services of an independent Testing Agency to perform Quality Assurance inspections and monitoring for all high purity systems. High purity systems are defined as those with a piping classification.

D. High purity, ultra high purity and contained ultra high purity tubing shall be inspected upon arrival at the job site to verify that tube and fittings are not damaged, the end caps seals are fixed and the enclosure bags are not damaged.

E. As much as possible of the installation and fabrication work shall be accomplished in the portable class 10,000 or better clean room.

F. Any tube or component not passing inspection shall not be incorporated into the work.

G. Each lot of stainless steel shall be spot tested for cleanliness prior to installation. Testing shall be done after tube cutting (if cutting is done). Test shall be the same as the "wad cleaning" testing procedure and subsequent drying and sealing described herein for piping classification Q (orbitally welded stainless steel).

H. Any tubing lot whose sample does not pass the cleanliness test shall not be incorporated into the work.

I. A representative sample of received stainless steel and hastelloy components shall be tested for cleanliness by swabbing exposed (reachable without disassembly) interior surfaces with a deionized water wetted cleanroom swab, and the swab examined for contamination.

J. Failure of components to pass test shall result in entire lot testing, with any failing parts to be returned to the factory.

K. A representative sample of stainless steel components shall be tested for leakage. Test may be done at the factory if witnessed by the testing agency or may be done in field. Leakage rates using helium shall be less than 10-9 cc/sec inboard across the body and less than 10-10 cc/sec across the seat in each test.

L. Installation of stainless steel and components shall be done only by qualified welders using the qualified welding procedures outlined in Part 3 of this specification.

M. Welder qualifications, weld inspections, shield and purge gas quality, and final acceptance testing shall be as outlined in Part 3 of this specification.

PART 2 - PRODUCTS

3.01 MATERIALS AND PRODUCTS

A. General: Provide piping materials, valves, and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in compressed gas handling systems. Where more than one type of materials or products are indicated, selection is Contractor's option. If gas is not listed below in section 2.01B, owner to determine construction material should be used.
   1. Provide orbitally welded stainless steel tubing for the following gasses:
      a. Helium
      b. Nitrogen

3.02 COMPRESSED GAS VALVE MANIFOLD SYSTEMS

A. Provide compressed gas valve manifold systems of either the three valve configuration. (Valve manifold systems shall be
   1. modular in design and shall include the following components, provided in materials as specified for the respective piping systems.
   2. Three Valve Manifold System.
   3. Provide three valve manifolds including:
      a. Purge gas inlet check and isolation valves with inlet piping extended to a fitting at the top of the cabinet.
      b. High pressure .5 micron stainless steel filter.
      c. High pressure isolation valve.
      d. High pressure vent check and isolation valve with vent piping extended to a fitting at the top of the cabinet.
      e. Regulator with bonnet vent and pressure relief valve with piping extended to a fitting at the top of the cabinet.
      f. Pigtail with appropriate CGA fitting.

3.03 ORBITALLY WELDED STAINLESS STEEL FOR ULTRA HIGH PURITY GAS PIPING

A. General:
   1. All products shall be fabricated, cleaned and packaged by the manufacturers in accordance with the requirements of this section. Products shall be provided in a state that facilitates installation without cleaning at the job site.
   2. As much as possible of the field fabrication shall be done in the Class 10,000 or better clean room. Class 10,000 or better clean room shall be portable type provided by the installing contractor and located in an approved location on the construction site.
   3. Coordinate final installation of sub-assemblies with all other trades. No installation shall proceed until all other major items of work have been completed.

B. Welding:
   1. As much as possible, welding of ultra high purity gas tubing and fittings shall be done in a Class 10,000 or better clean room at the construction site.
   2. All welding and fabrication shall be done while the system is under a dry high purity and filtered nitrogen or argon purge. After maximum amount of fabrication in the clean room is completed, open ends of sub-assembly shall be capped with a holding charge of pressurized purge gas prior to assembly at the final location.
   3. All tubing and fittings shall be welded utilizing pulsed arc automatic orbital Tungsten Inert Gas (TIG) welding machines. No filler wire or other filler materials shall be used. Welding shall be performed with a continuous flow of purge gas through the system as well as a protective pocket of purge gas at the TIG weld head.

C. Tubing and Fitting Products:
   1. Approved Manufacturers: Valex, Cardinal, or Advanced Micro-finish.

2. In addition to specialized material and procedural requirements, specialized inspection and testing requirements apply to piping classification Q, including components. See Quality Assurance for High Purity Systems in Part 1 of this specification.
3. Tubing and fittings shall be Type TP 316L seamless stainless steel for automatic orbital butt welding joints. All seamless stainless steel tubing and fittings, larger than 0.375 inches (9.52 mm) up to 1.500 inches (38.1 mm) in diameter shall meet the following ASTM Standard Specifications for Steel Tubing: A213, A269, A632 S3.1. All seamless stainless steel tubing and fittings,
    a. .375 inches (9.52 mm) and smaller in diameter shall meet ASTM Standard Specifications for Steel Tubing: A632, in addition to requirements above. All Welded Stainless Steel Tubing and fittings, 2.000 inches (50.8 mm) and larger in diameter shall meet the following ASTM Standard Specifications for Steel Tubing: A269, A270, A270 S1.1. All tubing and fittings shall be corrosion tested per ASTM A262, Practice
        1) E. All tubing and fittings shall be bright annealed in a dry hydrogen atmosphere (dew point ???= -40EC) or vacuum annealed (10 micron Hg). Tubing shall have a sulphur range of 0.005 to 0.012% weight for seamless and 0.005 to 0.017% weight for welded.
4. Bar stock shall conform to the requirements of ASTM A479.
5. Tubing and fittings I.D. shall be electropolished to semi-conductor grade to obtain an I.D. surface finish of 7 microinch Ra average, 10 microinch Ra maximum per ANSI B46.1.
6. Dimensional Tolerances:
    a. Permissible Variations in Dimensions.
    b. Seamless Tubing, per ASTM A632, Table 3: Permissible Variations in Dimensions, for applicable sizes.
    c. Welded Tubing, per ASTM A270, Table 2: Permissible Variations in Dimensions.

D. Ovality tolerance per ASTM A269.

E. Tubing and fitting ends shall be faced and squared to plus or minus one-half degree suitable for installation with automatic orbital fusion welding equipment.
1. Description Tolerance
2. Fittings +/- 1/32"
    a. Fittings +/- 1/2 Degree
    b. Tubing and Fittings +/- 10% Welded Tube +/- 12.5%
    c. 1/8" to 3/8" +0.004"/-0.000" 1/2" to 1" +/- 0.005"
    d. e. +/- 0.010"
    e. f. +/- 0.015"
        1) 1) .035"
            (a) .049"
            (b) .065"
            (c) .083"
            (d) .109"
            (e) .134"
            (f) .188"
3. Tubing shall be in exact 20 feet (609.6 cm) lengths, with no sulfur strings visible at the surface. Surface shall be chrome enriched, and average oxide depth (as determined by Auger or ESCA measurement) shall be greater than 20 angstroms. Minimum hardness on the Rockwell B scale shall be 80 RB.
4. Weldability: Either provide each tube lot from the same heat batch, or provide test results demonstrating satisfactory cross-heat weldability.

F. Gases and Deionized Water:

1. Nitrogen for drying and packaging shall be supplied from a liquid cryogenic source with the following point of use quality:
    (a) 99.999 percent
    (b) Less than 1 ppm
    (c) Less than 3 ppm
    (d) Less than 1 ppm
        (1) 10 particles or less larger than 0.01 microns per scf
        (2) 17.5 megohm/cm @ 25EC minimum
    (e) Less than 50 ppb
    (f) Less than or equal to 1/100 milliliters Filtration 0.1 micron at point of use
2. Deionized water purity shall conform to guidelines established by SEMI Pure Water 1990, Table 1.

G. Cleaning:
1. After electropolishing, tubing and fittings shall be cleaned with deionized water as a final cleaning agent and dried with heated nitrogen.
2. Final cleaning of tubing shall be performed in a permanent Class 10, FED-STD-209D specification, clean room using the following steps:
    a. Tubing shall be flushed with hot deionized water (60EC minimum) with rotation to uniformly heat and wet the interior surface to 60EC.
    b. A deionized water saturated plug shall be forced through the tube with filtered nitrogen. The plug shall be sized to require 50 psig (344.74 kPa) nitrogen pressure to force the plug through the tube.
    c. A dry plug shall be forced through the tube and the tube shall be examined for moisture. If moisture is present another dry plug shall be forced through and repeated until no visible moisture remains.
    d. The tubing shall be purged with heated nitrogen for one to three minutes with periodic rotation.
    e. Final cleaning of fittings shall be performed in a permanent Class 10, FED-STD-209D specification, clean room. Fittings shall be friction cleaned and rinsed with heated deionized water. Fittings shall be immediately dried with heated nitrogen. Fitting surfaces shall be closely examined for cleanliness before packaging.

H. Packaging:
1. Tubing and fitting ends shall be sealed with vinyl caps pressed over Aclar or polyamide nylon squares 1.75 mil (0.04445 mm) with a positive nitrogen purge, then double bagged with polyethylene bags. Inner bags shall be labeled with size, heat and part number.
2. Packaging for shipping shall be done to prevent damage to bagging, tubing and fittings.

I. Material Traceability:
1. Finished tubing and fittings shall be mill and heat traceable, permanently marked to correspond to original mill test reports.

J. Inspecting and Testing:
1. All tubing and components shall be visually inspected on interior surfaces to exhibit no macroscopic pitting, staining or discoloration.
2. All tubing and components shall be measured with calipers and/or micrometers or other appropriate methods to verify conformance to the dimensional requirements. Dimensional integrity shall be inspected on a sample basis per MIL-STD-105E, AQL 1.0, using a C=0 acceptance criteria.
3. All welded fittings shall be helium leak tested to a minimum 1 x 10-9 atm cc/sec gaseous helium.

4. Finished tubing and fittings in each heat lot shall be measured for interior surface finish with a Federal 4000 surfanalyzer in accordance with ASME B46.1. Surface roughness shall be measured at two locations for each piece tested at 180E increments. All tubing and components shall be subject to surface analysis at a sample quantity established per MIL-STD-105E, AQL 1.0, using a C=0 acceptance criteria. The average of the two readings shall not exceed 7 Ra microinch average with no single reading exceeding 10 Ra microinch. Sample length cutoff 0.030", traverse length shall be a minimum of 0.150" and drive speed shall be 0.010"/sec.
5. Scanning electron microscope (SEM) photographs of finished surfaces shall be analyzed at magnifications of 1000 X and 3500 X from each heat lot of electropolished raw material. SEM analysis shall be performed per SEMASPEC 90120401B-STD to verify that no more than 40 defects are distinguishable in the 3500 X field of view.
6. Electron spectroscopy for chemical analysis (ESCA) shall be analyzed from each heat lot of electropolished raw material. ESCA analysis shall be performed per SEMASPEC 90120403B-STD to verify chromium to iron ratios of 1.5:1 and chromium oxide to iron oxide ratios of 3:1.
7. Auger electron spectroscopy (AES) for analysis of surface and oxide composition shall be analyzed from each heat lot of electropolished raw material. Auger analysis shall be performed per SEMASPEC 91060573B-STD to verify oxide layer thickness of at least 20 angstroms.
8. Moisture testing shall be performed on 25% of cleaned tubing from each batch lot of a given size. Testing shall verify the addition of less than 1 ppm moisture to nitrogen gas, at a flow not exceeding 10 scfh/in2 of cross sectional area.
9. Particle testing shall be performed on 25% of cleaned tubing from each batch lot of a given size. Testing shall verify that particle counts are no more than 10 per cubic foot greater than 0.1 micron and zero greater than .3 micron while flowing nitrogen gas, at turbulent conditions.

K. Reports and Certifications:
   1. Provide the following test certifications for tubing and fittings:
      a. Raw Material Test Certification for heat analysis.
      b. Surface roughness certification.
   2. Provide the following for tubing:
      a. Scanning electron microscope (SEM) photos and certification.
      b. Electron spectroscopy for chemical analysis (ESCA) report and certification.
      c. Auger report and certification.
      d. Particle test certification.
      e. Moisture contribution test certification.
   3. Provide the following:
      a. Surface roughness profilometer charts.
      b. Particle test data.
      c. Moisture contribution test data.
      d. Resistivity Analysis.
      e. Material Weldability Test Samples.

L. Mechanical Joint Fittings (Face Seal Fittings):
   1. 316L stainless steel Crawford type VCR, Parker Vacuseal or Swegelok, factory cleaned and double bagged in polyethylene bags. Fittings shall have a helium leak rate of less than 10-10 cc/sec. Gaskets shall be ASTM B-162 polished soft nickel type with retainer clip; plated gaskets are not acceptable. Face seal fittings shall not be used for hazardous or toxic gas systems.

M. Valves:
   1. Approved Manufacturers: AP Tech, Nupro (ELD series), Veriflo (Quantum series), Parker or Carten.
   2. Valves shall be springless packless diaphragm type, 316L stainless steel VIM/VAR body construction with Kel-F seats and Parker Vacuseal end connections with soft nickel gasket ASTM B-162; plated gaskets are not acceptable. Valves shall be ultra high purity cleaned and shall be electropolished to semi-conductor grade as specified under tubing. "Wetted" surfaces shall not contain brass, bronze or other copper containing material. Valve shall be rated for a maximum working pressure of 250 psig (1723.69 kPa). Valves shall not have purge ports.
   3. Helium leak rates shall be as follows:
      a. Components: Inboard <2 x 10-10 cc/sec for general nitrogen service; <10-10 cc/sec for other services.
      b. Across the Seat: <4 x 10-8 cc/sec.
      c. Outboard: <2 x 10-9 cc/sec.
   4. Valves shall be factory capped while under ultra high purity nitrogen purge and double-bagged and sealed in clean polyethylene bags.

N. Purge, Test, Shield and Drying Gases:
   1. Argon for Purge: To have a minimum purity of 99.9999% with a maximum of 0.2 ppm 02,
      a. 0.1 ppm hydrocarbons, and 0.5 ppm moisture. Gas shall be filtered to 0.02 microns absolute.
   2. Nitrogen for Test: To have a minimum purity of 99.9995% with a maximum of 0.5 ppm 02, 1 ppm CO, 1 ppm CO2 and 0.5 ppm hydrocarbons, 2 ppm H20, and a dewpoint of - 100E or lower and shall be filtered to 0.02 microns.
   3. Helium for Test: To have a minimum purity of 99.9999% with a maximum of 0.5 ppm 02 and moisture, 0.1 ppm CO and CO2, and shall be filtered to 0.02 microns absolute.

O. Installation:
   1. See High Priority Gas Piping Installation in Part 3 of this specification.

P. Pressure Testing:
   1. Pressurize the completed system to 150 psig (1034.21 kPa) with helium. Check all connections and fittings with a portable leak detector such as a Varian Porta-Test leak detector. Do not use leak detection fluid such as "Snoop" or "Leaktec". Repair any defect, taking care to minimize system contamination. After completion of outboard leak test, repeat procedure using a vacuum inside the tubing (inboard leak test), again repairing any defects.
   2. The Owner's Representative shall witness all tests.
   3. Owner Verification of Cleanliness: The Owner shall retain the right to test (or have testing done by Others) all orbitally welded stainless steel piping for cleanliness prior to acceptance in accordance with procedures deemed appropriate by Owner. In the event that any piping system is found to be contaminated or otherwise not acceptable to Owner, Owner may require that Contractor replace such piping system or Owner may have the piping system cleaned at Contractor's expense. If Owner has piping system cleaned and it is still found to be unacceptable, Contractor shall replace the piping system at no additional charge to Owner, or Owner may elect to have the system replaced by Others at Contractor's expense.

3.04 BASIC IDENTIFICATION

A. General: Provide identification complying with Division-15 Section "Mechanical Identification", in accordance with the following listing:
   1. Compressed Gas Piping: Plastic pipe markers.

2. Compressed Gas Signs: At each shutoff valve, provide sign identifying valve service.
3. All gas labeling shall be color coded in accordance with Section 12350.

PART 3 - EXECUTION

4.01 INSPECTION

A. Examine areas and conditions under which laboratory gas systems and equipment are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

4.02 IDENTIFICATION

A. General: Install mechanical identification in accordance with Division-15 Section "Mechanical Identification", in accordance with the following:

B. General: Provide identification complying with Division-15 Basic Mechanical Materials and Methods section "Mechanical Identification", in accordance with the following listing:
   1. Compressed Gas Piping: Plastic pipe markers.
   2. Compressed Gas Signs: At each shutoff valve, provide sign identifying valve service.
   3. All gas labeling shall be color coded in accordance with Section 12350.

4.03 PIPING INSTALLATION, GENERAL REQUIREMENTS

A. The work under this section is part of a complex facility which requires the integration of work provided under many sections. The Contractor shall cooperate with others providing work under other sections of these Contract Documents. The Contractor shall plan all work such that the completed project accomplishes the Owner's objectives and the Contract requirements in the most efficient, neat, orderly, serviceable and coordinated manner.

B. Valves and in-line piping specialties shall be located so that they are readily accessible for operation and maintenance.

C. Provide valves for isolating and servicing of all equipment and components which require periodic service or removal. Valves shall be provided in the branch piping to each such device, located such that the flow in the main line is not disturbed as a result of use of the branch valve.

D. Where different metallic piping materials are connected together, or where piping material differs from that of the equipment to which it is connected, provide dielectric unions or flanges with approved electrolytically isolated gaskets.

E. Cut pipe to lengths established in the field based on accurate measurement of requirements to insure that piping may be installed without bending or forcing.

F. Cut all piping with tubing cutters or other means as recommended by pipe manufacturer for the specific service to insure square, clean cuts with minimum of burrs. Where specific requirements herein exceed manufacturer's recommendations, comply with requirements herein.

G. Ream all piping in an approved manner to remove all burrs prior to making-up joints. Adhere strictly to requirements for specialty piping as outlined in Part 2 herein.

H. Clean and otherwise prepare the ends of all pipe and fittings prior to joining.

I. Use strap wrenches or other means to protect piping when holding pipe for cutting or other fabrication procedures. Vises or other clamping devices which mar the pipe surface are not acceptable.

J. All changes in pipe size shall be made with reducing fittings. Bushings will not be allowed.

K. Piping and tubing lines arranged and routed by Contractor shall be routed parallel to one another and to piping detailed on drawings.

L. Pipe and tubing runs and all work provided under this section shall not obstruct doorways, passageways, instruments and electrical panels, other equipment, or the work of other trades and shall be routed to minimize possibility of damage to the piping from traffic in the area.

M. The Contractor shall obtain the approval of routing and arrangement of field run piping from the Owner's Representative and Construction Manager before the piping is installed

N. Install compressed gas piping parallel to building walls and other piping.

O. Grade horizontal piping minimum of ¼" in 15 feet (457.2 cm) towards low points at risers or end of mains.

P. Branch take-offs shall be taken from the tops of horizontal mains.

Q. Laboratory gas installation shall conform to NFPA 45, 56F and Compressed Gas Association Standards.

R. Valves:
   1. Shut-off valves for each laboratory gas main shall be provided.

S. Connect laboratory supply piping to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

4.04 PRESSURE TESTING

A. Piping shall be pneumatically pressure tested as called for in the Pipe Classification Section of these specifications. The Contractor shall verify that each component of a piping system is capable of withstanding the required test pressure without damage and protect or remove from the system any equipment which could sustain damage because of over pressure.

B. Test pressures shall be held for a period of 24 hours unless specified otherwise in the Pipe Classification section of these specifications.

C. No system shall be accepted by the Owner if any leaks are observed during the test. Any component or pipe joint which leaks during a test shall be replaced or repaired, and the system shall be retested to verify that it is sound before acceptance by the Owner.

D. Gas for pressure testing shall be provided by Contractor. Test solutions shall be furnished by the Contractor.

E. All testing shall be witnessed by the Owner.

4.05 HIGH PURITY STAINLESS STEEL GAS PIPING INSTALLATION

A. Fabrication:
   1. Follow procedures outlined herein for general requirements regarding layout, cutting, preparation of pipe and fittings supports, coordination, service access, etc. prior to fabrication and installation.

B. Welding: All welding shall be done using an automatic orbital welding machine making autogenous welds using a tungsten-inert gas process. The electrode shall be contained within a shielded head and shall rotate 360E within the head.

C. As much as possible of the cutting, welding and fitting operations must be made in the clean room. The entire welding process shall be done while the system is under a high purity nitrogen or argon purge.

D. Fitters and welders shall wear white lint-free gloves while fabricating and installing.

E. Argon gas for purge shall be continuously kept on all uncapped tubing. This shall include both tubing on the fabrication bench and installed tubing not yet in service. Purge gas connections to tubing or weld assemblies must be hard stainless steel tubing connections. Compression fittings

1. are acceptable for this temporary use, but plastic tubing (teflon, nylon, etc.) is unacceptable due to moisture infiltration through the wall. Prepare joints as follows:
2. Cut ends shall be faced to be square to a tolerance of 0.003 inch (0.08 mm). Tubing shall be cut and faced using a portable facing tool (Tri-Tool or equal) or a lathe. No cutting fluid shall be used. The tubing shall not be scratched during debarring. Abrasive wheels or saws shall not be used.
3. Set up the fabrication on the work bench or field fit. Verify that the argon gas for purge is connected to one end of the assembly. Test for quality of the argon backing purge with an oxygen analyzer.

F. Quality Assurance:
1. Welding shall be in accordance with a qualified welding procedure. A sample weld shall be made before each series of welding operations. A sample weld shall be made:
   a. At the beginning of the day.
   b. After lunch breaks.
   c. After changing power sources or shut down of power.
   d. After changing weld heads.
   e. After changing tube sizes.
   f. After any change in weld program.
   g. After changing purge gas source.
   h. After any other change that might affect the weld.
2. All sample welds shall be approved by the Testing Agency.
3. All welding must meet the requirements of the American Standard Code for Pressure Piping, ANSI B31.3, and ASME Boiler and Pressure Vessel Code. The Contractor shall provide certification that the welding procedure and welding operators have been qualified by the Testing Agency responsible for compliance with this specification.
4. Completed construction welds shall be inspected by Contractor's superintendent as part of Contractors Quality Assurance program. In addition, the Construction Manager and the testing Agency will inspect welds wherever practical. The following defects will be cause for weld rejection:
   a. Oxidation levels dark brown to black in surface appearance or "rainbowing", as compared to acceptable samples.
   b. Skips (lack of fusion). Internal areas of the joint which have not been properly consumed.
   c. Undercut of base material, interior or exterior.
   d. Poor alignment of joint, or out of tolerance with joint preparation specified previously.
   e. Evidence of any heat cracking, internal or external.
   f. Pinholes of any sort.
   g. Excessive internal crevice.
   h. Weld current fluctuation causing irregular bead appearance and tracking.
   i. Surface oxidation products or excessive silicone inclusion on interior weld surface.
   j. Evidence of leaking during final test.

G. Welding Requirements:
1. During welding, all "high purity" lines shall be purged with clean, dry gas as specified herein. The purge gas shall be allowed to escape to atmosphere through a perforated plug or purge port at the end of pipe run.
2. Fittings shall be round, true and new. Fittings, once used, shall not be reused.
3. The minimum purge flow rates will be in accordance with the following table:
   a. PURGE FLOW RATE TABLE

	Nom. Pipe/Tube Size	SCFH	Liters/Min.
	1/4" and 3/8"	1.5	0.75
	1/2"	5	2.50

4. Do not disassemble components for cleaning.
5. Do not use solvents, freons, alcohols or other hydrocarbon based fluids for cleaning.
6. After tube cutting and debarring, but before welding, tubing shall be field cleaned indoors under a filtered hood or similar Owner-approved arrangement.
7. Field Cleaning Steps:
   a. Remove loose interior particles by blowing a lint-free wet (deionized water) wipe through tube until clean;
   b. Blowing a dry wipe through tubing to remove water;
   c. Dry filtered (0.01 micron) nitrogen purge to less than 5 PPM moisture content; and
   d. Resealing with Aclar film and plastic caps.
8. Once the time required for reaching a 5 PPM moisture content at a given purge rate is established, re-measuring for a 5 PPM content for each tube is not required, time may be used as a determinant factor.
9. Tubing received from the manufacturer judged to be slightly contaminated may, at the option of the Quality Assurance person, be field cleaned prior to cutting in lieu of returning it to the manufacturer.

H. Installation of Components:
1. Regulators shall be installed for services as scheduled on the Drawings. Verify need for regulator installation on elevations and/or sections.
2. Valves and filters shall be installed for services as scheduled on the Drawings.
3. Install services adjacent to each other when possible, to maximize available space and minimize interferences.

I. Field Bending Limitations:
1. Bending 316L stainless steel and hastelloy C-276 to too tight a radius will result in deterioration of the inner surface. Not only does this provide an increased potential for
   a. contamination, but it also weakens the tubing strength considerably. Since the tubing is used for containment of gasses that can be under high pressure and/or toxic or corrosive, it is imperative that field bending limitations be observed. Failure to meet field bending limitations be observed. Failure to meet field bending limitations will be considered to be not only cause for automatic replacement, but is considered an unsafe work practice as well.
2. Field bending for 1/4", 3/8" and 1/2" diameter tubing may be done only where a minimum of 10 tube diameters is used as the bending radius.

END OF SECTION 226319

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SECTION 226600
CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single-wall piping.

B. Joints for acid-waste systems.

C. Traps, drains, and cleanouts.

D. Neutralization tanks.

E. Neutralization (pH) monitoring system.

F. Leak detection system.

1.02 RELATED REQUIREMENTS

A. Section 003100 - Available Project Information.

B. Section 099123 - Interior Painting.

C. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.

D. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.

E. Section 220553 - Identification for Plumbing Piping and Equipment.

F. Section 230923 - Direct-Digital Control System for HVAC.

G. Section 251400 - Integrated Automation Local Control Units.

H. Section 312316 - Excavation.

I. Section 312316.13 - Trenching.

1.03 REFERENCE STANDARDS

A. 40 CFR 280 - Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks; current edition.

B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.

C. ASPE 3 - Plumbing Engineer Design Handbook, Vol. 3; 2019.

D. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

E. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

F. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

G. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2025.

H. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2019a.

I. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials; 2021.

J. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2017 (Reapproved 2021).

K. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials; 2024.

L. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2023.

M. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.

N. ASTM F1673 - Standard Specification for Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems; 2010, with Editorial Revision (2021).

O. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 1989.

P. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

R. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

S. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

C. Scheduling: Coordinate downtime duration to transfer existing service to temporary or replacement system.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data:
   1. Pipe, fittings, tanks, manholes, joints, and related accessories.
   2. Solvents and adhesives highlighting VOC content.
   3. Leak detection system, including interconnected devices.

C. Shop Drawings:
   1. Neutralization Tank:
      a. Show plan(s), elevations, sections, details, and attachments to other work.
      b. Components assembly, dimensions, weights, loads, clearances, and field assembly instructions with piping connection details.
   2. Leak Detection System:
      a. Components assembly, dimensions, weights, clearances, and field assembly instructions with interconnectivity details.
      b. Mechanical and Electrical Schematics: Include end-to-end wiring diagrams for power, signal, and control wiring.
   3. Coordination Drawings, Scaled:
      a. Pipe sizes, locations, and elevations. Include associated reflected ceiling plan(s)
      b. Other piping in same trench and clearances from sewerage system piping.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, fittings, and seals from dirt and damage.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 SINGLE-WALL PIPE

A. CPVC (Chlorinated Polyvinyl Chloride) Piping:
   1. Manufacturers:
      a. Aetna Plastics Corp; _____: www.aetnaplastics.com/#sle.
      b. GF Piping Systems; _____: www.gfps.com/#sle.
      c. IPEX USA, LLC; _____: www.ipexna.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Fabrication: ASTM F441/F441M, schedule 40 pipe and fittings with minimum cell classification of 24448.
   3. Join Method: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.
   4. Required Pipe Segment Length: 10 feet (3 m).
   5. Transition Fittings: Provide combinations of clamps, couplings, adapters, and gaskets; compatible with installed products and service fluids when joining different piping materials.

B. PVDF (Polyvinylidene Fluoride) Piping:
   1. Manufacturers:
      a. Aetna Plastics Corp; _____: www.aetnaplastics.com/#sle.
      b. GF Piping Systems; _____: www.gfps.com/#sle.
      c. IPEX USA, LLC; Plenumline: www.ipexna.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. Fabrication: ASTM D3222, schedule 40 pipe and fittings.
   3. Corrosive Waste Drain Service: ASTM F1673.
   4. Join Method: Butt-fused welding.
   5. Required Pipe Segment Length: 10 feet (3 m).

2.02 JOINTS FOR ACID-WASTE SYSTEMS

A. Manufacturers:
   1. Asahi/America; _____: www.asahi-america.com/#sle.
   2. GF Piping Systems; _____: www.gfps.com/#sle.
   3. IPEX USA, LLC; _____: www.ipexna.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Flame-Retardant PVDF (Polyvinylidene Fluoride) Mechanical Joints:
   1. Fittings Fabrication: ASTM D3222, schedule 40.
   2. Size: 1-1/2 to 4 inch (40 to 100 DN in mm).
   3. Basis of Design: IPEX USA, LLC; Plenumline: www.ipexna.com/#sle.

C. Solvent-Weld Joints:
   1. CPVC (Chlorinated Polyvinyl Chloride): ASTM F441/F441M, solvent weld with ASTM F493 solvent cement.
      a. Formaldehyde volatile organic chemical (VOC) indoor emissions from solvent cement is not to exceed 7 ppb (parts per billion or mg per cubic meter).
      b. Solvent cement volatile organic chemical (VOC) indoor emissions are not to exceed 510 grams/L.

D. Couplings:
   1. Shielded, Heavy Duty No-Hub Couplings:
      a. Testing: In accordance with ASTM C1540 and FM 1680.
      b. Gasket Material: Neoprene complying with ASTM C564.
      c. Band Material: Stainless steel.
      d. Eyelet Material: Stainless steel.

E. Dissimilar Pipe Material Joints: Provide adapters, transition fittings including combination assemblies with clamps, couplings, adapters, gaskets, threaded, flanged, socket, and others.

2.03 TRAPS, DRAINS, AND CLEANOUTS

A. Manufacturers:
   1. Aetna Plastics Corp; _____: www.aetnaplastics.com/#sle.
   2. IPEX USA, LLC; _____: www.ipexna.com/#sle.
   3. Zurn Industries, LLC; Z9A-PHIX: www.zurn.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Acid Dilution Traps:
   1. Material: CPVC (Chlorinated Polyvinyl Chloride) with removable tank lid-base.
      a. CPVC: Solvent weld with ASTM F493 solvent cement.
      b. Formaldehyde volatile organic chemical (VOC) indoor emissions from solvent cement is not to exceed 7 ppb (parts per billion or mg per cubic meter).
      c. Solvent cement volatile organic chemical (VOC) indoor emissions are not to exceed 510 grams/L.
   2. Tank Type: 1 Gallon (3.7 L) made of polypropylene.
   3. Size Connection: 1-1/2 inch (40 DN in mm), slip-union inlet and socket-union outlet.

C. Corrosion-Resistant Traps:
   1. Type: P-trap or drum trap.
   2. Size: 1-1/2 inch (40 DN in mm) matching inlet and outlet connections.
   3. PVDF: ASTM D3222, with mechanical joint pipe connections.
   4. CPVC: Solvent weld with ASTM F493 solvent cement.
      a. Formaldehyde volatile organic chemical (VOC) indoor emissions from solvent cement is not to exceed 7 ppb (parts per billion or mg per cubic meter).
      b. Solvent cement volatile organic chemical (VOC) indoor emissions are not to exceed 510 grams/L.

D. Floor Cleanouts:
   1. Cover: 5 inch (127 mm) diameter stainless steel cleanout cover.
   2. Outlet: 1 inch (25 DN in mm) connected through fitted-bottom.

3. CPVC: Solvent weld with ASTM F493 solvent cement.

2.04 NEUTRALIZATION TANKS

A. Manufacturers:
   1. Gei Works; _____: www.erosionpollution.com/#sle.
   2. IPEX USA, LLC; _____: www.ipexna.com/#sle.
   3. Town & Country Plastics, LLC; _____: www.tandcplastics.com/#sle.

B. Tank Capacity: 15 Gallon (56.8 L).

C. Form Factor: Rectangular shape made of acid-resistant material.

D. Material: HDPE (high-density polyethylene) cast with built-in piping connections and bolted, gastight, load bearing cover with 8 inch (203.2 mm) handhole access port.

E. Piping Tie-in: Flanged connection for inlet, outlet, and vent piping sides.

F. Accessories:
   1. Top-mounted high and low level alarm switch.
   2. Level Monitoring Alarm Panel: NEMA EN 10250 and UL 50/UL 50E compliant for nonhazardous locations:
      a. Mechanical, Electrical Rooms (MER): Use NEMA EN 10250, Type 12.
   3. Limestone Chips: 1 to 3 inch (25 to 75 mm) diameter chips with calcium carbonate content in excess of 90 percent.

2.05 NEUTRALIZATION (PH) MONITORING SYSTEM

A. Manufacturers:
   1. IPEX USA, LLC; _____: www.ipexna.com/#sle.
   2. Orion, a Watts brand; _____: www.watts.com/usa/#sle.
   3. Town & Country Plastics, LLC; _____: www.tandcplastics.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Microprocessor-based single-pH monitoring panel with face-mounted indicating backlit single-line display, system interface touch-buttons, electronic-erasable memory, audio-visual alarm rated at 75 dB, and separate momentary-type push-buttons for functions such as power cycling and alarm silencing.

C. Effluent pH Electrode Probe: Industrial airtight type fitted with 32 feet (10 m) long cable.
   1. Sampling Tank: 5 Gallon (18.8 L), HDPE (high-density polyethylene) with sidewall flanged inlet and flanged outlet connections.
   2. Probe Fitting: On top of sampling tank bolted-down cover made of the same material.
   3. Provide sampling tank support with the length to align with neutralization tank level.

D. Panel Controls Interface:
   1. On/Off hand-switch or button with indicating light.
   2. pH value with high-pH, low-pH, and fault status indicators.
   3. Fault status indicator.
   4. Alarm: Indicating light with horn, silencer switch, and reset switch.

E. Panel Outputs:
   1. pH Level: 4 to 20mA DC.
   2. Common alarm relay.
   3. Fault status relay.

F. Enclosure Rating: NEMA EN 10250 and UL 50/UL 50E compliant for nonhazardous locations:

2.06 LEAK DETECTION SYSTEM

A. Manufacturers:
   1. Asahi America; _____: www.asahi-america.com/#sle.
   2. GF Piping Systems; _____: www.gfps.com/#sle.
   3. IPEX USA, LLC; _____: www.ipexna.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Environmental Operating Range:
   1. Temperature: 0 to 120 degrees F (minus 18 to 50 degrees C).
   2. Humidity: 10 to 90 percent RH (noncondensing).

PART 3 EXECUTION

3.01 EXAMINATION

A. Review plans and details to confirm general aboveground and specific belowground location and arrangement of system piping and equipment.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Remove scale and dirt, on inside and outside, before assembly.

B. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions beginning at low point, true to grades and alignment indicated with unbroken continuity of invert.

B. Excavate and backfill in accordance with Section 312316.

C. Trench and backfill in accordance with Section 312316.13.

D. Group piping whenever practical at common elevations, especially for buried piping.

E. Belowground Tanks: Install tank cover flush with finished surface unless directed otherwise.

F. Provide nonconducting dielectric connections wherever jointing dissimilar metals.

G. Route piping in orderly manner and maintain gradients while running parallel and perpendicular to walls.

H. Provide sleeves for pipes passing through partitions, walls, and floors.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.

J. Provide hangers and supports for aboveground piping according to Section 220529.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Install valves with stems upright or horizontal, not inverted, and provide access handholes where buried.

M. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
   1. See Section 099123 for painting of interior plumbing systems and components.

N. Install, wire, and terminate electrical components, devices, and accessories according to manufacturer instructions using products listed and labeled intended application usage in compliance with NFPA 70 requirements.

O. Identify installed piping, equipment, and accessories as indicated in Section 220553.

P. Interface With Other Work: Allow full remote monitoring by Section 251400 of:

1. Discharge pH level.
2. Leak detection alarm contact.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide manufacturer's field representative to observe installed systems.

C. Carefully inspect and replace installed products found incompatible, crushed, broken, cracked, leaking, or otherwise damaged.

D. Execute hydrostatic tests to acid waste, drain, and vent piping.

3.05 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform neutralization system startup.

3.06 COMMISSIONING

A. See Section 019113 - General Commissioning Requirements.

3.07 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals for data format instructions.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate operation of system to Owner's personnel.
1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

END OF SECTION 226600

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SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

B. Section 262913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.

C. NEMA MG 00001 - Motors and Generators; 2024.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 5 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group; _____: www.baldor.com/#sle.

B. Leeson Electric Corporation; _____: www.leeson.com/#sle.

C. Regal-Beloit Corporation (Century); _____: www.centuryelectricmotor.com/#sle.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Section 260583 for required electrical characteristics.

B. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 1/2 Horsepower: 480 volts, three phase, 60 Hz.

C. Nominal Efficiency:
   1. Open Motor with Two Poles: 82.5.
   2. Open Motor with Four Poles: 82.5.
   3. Enclosed Motor with Two Poles: 75.5.
   4. Enclosed Motor with Four Poles: 82.5.
   5. Enclosed Motor with Six Poles: 50.0.

D. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F (40 degrees C) environment.
   3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
   4. Motors with frame sizes 254T and larger: Energy efficient type.

E. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

G. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Single phase motors for shaft mounted fans and centrifugal pumps: Split phase type.

B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

C. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

D. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

E. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 262913.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 00001.

K. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

M. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

N. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.08 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:
   1. Commercial:
      a. Roof Top Unit:
         1) Operating Mode: Constant speed.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the roof top unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) RPM: 300 through 1200.
      b. DX Fan Coil Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the DX fan coil unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) Options: Remote mount control/User-Interface.
         5) RPM: 300 through 1250.
      c. Package Terminal Air Conditioner (PTAC):
         1) Operating Mode: Constant speed.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the PTAC and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) RPM: 600 through 1800.
      d. Power Roof Ventilator (PRV):
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) Options: Remote mount control.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULE

A. NEMA Open Motor Service Factors.

1. 1/6-1/3 hp:
   a. 1800 rpm: 1.35.
   b. 1200 rpm: 1.35.
2. 1/2 hp:
   a. 1800 rpm: 1.25.
   b. 1200 rpm: 1.25.
3. 3/4 hp:
   a. 1800 rpm: 1.25.
   b. 1200 rpm: 1.15.
4. 1 hp:
   a. 1800 rpm: 1.15.
   b. 1200 rpm: 1.15.
5. 1.5-150 hp:
   a. 1800 rpm: 1.15.
   b. 1200 rpm: 1.15.
   c. 900 rpm: 1.15.

B. Three Phase - Energy Efficient, Open Drip-Proof Performance:
1. 1800 rpm.
   a. 1 hp:
      1) NEMA Frame: 143T.
      2) Minimum Percent Power Factor: 84.
      3) Minimum Percent Efficiency: 82.
   b. 1-1/2 hp:
      1) NEMA Frame: 145T.
      2) Minimum Percent Power Factor: 85.
      3) Minimum Percent Efficiency: 84.
   c. 2 hp:
      1) NEMA Frame: 145T.
      2) Minimum Percent Power Factor: 85.
      3) Minimum Percent Efficiency: 84.
   d. 3 hp:
      1) NEMA Frame: 182T.
      2) Minimum Percent Power Factor: 86.
      3) Minimum Percent Efficiency: 86.
   e. 5 hp:
      1) NEMA Frame: 184T.
      2) Minimum Percent Power Factor: 87.
      3) Minimum Percent Efficiency: 87.
   f. 7-1/2 hp:
      1) NEMA Frame: 213T.
      2) Minimum Percent Power Factor: 86.
      3) Minimum Percent Efficiency: 88.
   g. 10 hp:
      1) NEMA Frame: 215T.
      2) Minimum Percent Power Factor: 85.
      3) Minimum Percent Efficiency: 89.

C. Three Phase - Energy Efficient, Totally Enclosed, Fan Cooled Performance:
1. 1800 rpm.

a. 1 hp:
   1) NEMA Frame: 143T.
   2) Minimum Percent Power Factor: 84.
   3) Minimum Percent Efficiency: 82.
b. 1-1/2 hp:
   1) NEMA Frame: 145T.
   2) Minimum Percent Power Factor: 85.
   3) Minimum Percent Efficiency: 84.
c. 2 hp:
   1) NEMA Frame: 145T.
   2) Minimum Percent Power Factor: 85.
   3) Minimum Percent Efficiency: 84.
d. 3 hp:
   1) NEMA Frame: 182T.
   2) Minimum Percent Power Factor: 83.
   3) Minimum Percent Efficiency: 87.
e. 5 hp:
   1) NEMA Frame: 184T.
   2) Minimum Percent Power Factor: 83.
   3) Minimum Percent Efficiency: 88.
f. 7-1/2 hp:
   1) NEMA Frame: 213T.
   2) Minimum Percent Power Factor: 85.
   3) Minimum Percent Efficiency: 89.
g. 10 hp:
   1) NEMA Frame: 215T.
   2) Minimum Percent Power Factor: 84.
   3) Minimum Percent Efficiency: 90.

END OF SECTION 230513

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 230548 - Vibration and Seismic Controls for HVAC.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.

D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.

E. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

I. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

L. FM (AG) - FM Approval Guide; Current Edition.

M. MFMA-4 - Metal Framing Standards Publication; 2004.

N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

O. UL (DIR) - Online Certifications Directory; Current Edition.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
   1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

D. Installer's Qualifications: Include evidence of compliance with specified requirements.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

C. Installer Qualifications for Field-Welding: As specified in Section 055000.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    a. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    c. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Section 055000.

C. Prefabricated Trapeze-Framed Metal Strut Systems:
1. Manufacturers:
    a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    b. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
    c. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.
    d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
    e. Substitutions: See Section 016000 - Product Requirements.
    f. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. MFMA-4 compliant, prefabricated, side-loading continuous-slot metal strut channel bracket with associated tracks, fittings, and related accessories.
3. Strut Channel or Bracket Material:
    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
5. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

D. Strut Channels:
1. Manufacturers:
    a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    b. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
    c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
    d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

E. Channel Nuts:
1. Manufacturers:

a. FNW; 7821: www.fnw.com/#sle.
b. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

F. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
a. Equipment Supports: 1/2 inch (13 mm) diameter.
b. Piping up to 1 inch (25 mm, DN): 1/4 inch (6 mm) diameter.
c. Piping larger than 1 inch (25 mm, DN): 3/8 inch (10 mm) diameter.

G. Cable Hanging System Kits:
1. Manufacturers:
a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
b. Ductmate Industries, Inc: ductmate.com/#sle.
c. Gripple, Inc: www.gripple.com/#sle.
d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Provide cable-wire in bulk or precut lengths with respective cable hangers as required to hold minimum weight of 120 lb (54.4 kg).
3. Accessories: Provide brackets, clip or c-clip hangers, covers, and y-hook hangers.

H. Thermal Insulated Pipe Supports:
1. Manufacturers:
a. Buckaroos, Inc: www.buckaroos.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
2. General Requirements:
a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch (15 to 750 mm, DN) iron pipes.
d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
3. PVC Jacket:
a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
b. Moisture Vapor Transmission: 0.0071 perm inch (0.0092 ng/Pa s m), when tested in accordance with ASTM E96/E96M.
c. Thickness: 60 mil (1.524 mm).

I. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F (50 degrees C):
a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
b. Support From Below: MSS SP-58 Types 35 through 38.
3. Operating Temperatures from 122 to 446 degrees F (50 to 230 degrees C):

a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.
c. Sliding Support: MSS SP-58 Types 35 through 38.

J. Pipe Stanchions:
1. Manufacturers:
a. Anvil International; H-Block: www.anvilintl.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
3. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
4. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

K. Beam Clamps:
1. Manufacturers:
a. FNW; 7201: www.fnw.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
3. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
4. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
5. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
6. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
7. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
8. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
9. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

L. Riser Clamps:
1. Manufacturers:
a. FNW; 7020: www.fnw.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
5. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.

6. UL (DIR) listed: Pipe sizes 1/2 to 8 inch (15 to 200 mm, DN).

M. U-Bolts:
   1. Manufacturers:
      a. FNW; 7610: www.fnw.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
      c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.

N. Strut Clamps:
   1. Manufacturers:
      a. FNW; 7815: www.fnw.com/#sle.
      b. Gripple Inc; GCS: www.gripple.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.
      d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.
   3. Cushioned Pipe or Tubing Strut Clamp: Provide strut clamp with thermoplastic elastomer cushion having dielectric strength of 670 V/mil (26,398,000 V/m).
   4. Service Temperature Range: Minus 65 to 275 degrees F (Minus 53.8 to 135 degrees C).

O. Insulation Clamps:
   1. Manufacturers:
      a. FNW; 7897: www.fnw.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.
      c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. Two bolt-type clamps designed for installation under insulation.
   3. Material: Carbon steel with epoxy copper or zinc finish.

P. Pipe Hangers:
   1. Split Ring Hangers:
      a. Manufacturers:
         1) FNW; 7001: www.fnw.com/#sle.
         2) Substitutions: See Section 016000 - Product Requirements.
      b. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
      c. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
      d. Provide hanger rod and nuts of the same type and material for a given pipe run.
      e. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
   2. Band Hangers, Adjustable:
      a. Manufacturers:
         1) Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
         2) Substitutions: See Section 016000 - Product Requirements.
         3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
      b. MSS SP-58 Type 7 or 9, Zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
   3. J-Hangers, Adjustable:

a. Manufacturers:
1) FNW; 7025: www.fnw.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
b. MSS SP-58 Type 5, Zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

4. Swivel Ring Hangers, Adjustable:
a. Manufacturers:
1) FNW; 7010: www.fnw.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
b. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
c. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
d. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.

5. Clevis Hangers, Adjustable:
a. Manufacturers:
1) FNW; 7005: www.fnw.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
b. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
c. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
d. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
e. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch (65 to 200 mm, DN).

Q. Intermediate Pipe Guides:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Pipe Diameter 6 inch (150 mm, DN) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).
3. Pipe Sizes 8 inch (200 mm, DN): 0.625 inch (16 mm) U-bolt with double nuts providing minimum clearance of 0.28 inch (7 mm).
4. Pipe Size 10 inch (250 mm, DN): 0.75 inch (19 mm) U-bolt.
5. Pipe Sizes 12 to 16 inch (300 to 400 mm. DN): 0.875 inch (24 mm) U-bolt.
6. Pipe Sizes 18 to 30 inch (450 to 750 mm, DN): 1 inch (25 mm) U-bolt.
7. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

R. Pipe Alignment Guides:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. The Metraflex Company; Style IV Spider Type Guide: www.metraflex.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Pipe Sizes 8 inch (200 mm, DN) and Smaller: Spider or sleeve type.

3. Pipe Sizes 10 inch (250 mm, DN) and Larger: Roller type.

S. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

T. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
   1. Manufacturers:
      a. Anvil International; H-Block: www.anvilintl.com/#sle.
      b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      c. Erico International Corporation, a brand of Pentair: www.erico.com/#sle.
      d. Green Link, Inc: www.greenlinkengineering.com/#sle.
      e. PHP Systems/Design: www.phpsd.com/#sle.
      f. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
      g. Substitutions: See Section 016000 - Product Requirements.
   2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   4. Mounting Height: Provide minimum clearance of 6 inches (150 mm) under supported component to top of roofing.

U. Anchors and Fasteners:
   1. Manufacturers - Mechanical Anchors:
      a. FNW; 7502: www.fnw.com/#sle.
      b. Hilti, Inc: www.us.hilti.com/#sle.
      c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
      d. Powers Fasteners, Inc: www.powers.com/#sle.
      e. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   2. Manufacturers - Powder-Actuated Fastening Systems:
      a. Hilti, Inc: www.us.hilti.com/#sle.
      b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
      c. Powers Fasteners, Inc: www.powers.com/#sle.
      d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
   3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   6. Hollow Masonry: Use toggle bolts.
   7. Hollow Stud Walls: Use toggle bolts.
   8. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.
   9. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.
   10. Sheet Metal: Use sheet metal screws.
   11. Wood: Use wood screws.
   12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
      a. Comply with MFMA-4.
      b. Channel Material: Use galvanized steel.

c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm) minimum base metal thickness.
d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

V. Pipe Installation Accessories:
1. Copper Pipe Supports:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Thermal Insulated, Surface-Mounted Pipe Supports:
a. Manufacturers:
1) FNW; 7701: www.fnw.com/#sle.
2) HoldRite, a brand of Reliance Worldwide Corporation; _____: www.holdrite.com/#sle.
3) Substitutions: See Section 016000 - Product Requirements.
4) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
b. Material: Carbon steel with epoxy copper or zinc finish.
c. Weather and UV light resistant foam, plastic, or rubber material with built-in strut. Maximum Load: 50 lb (22.7 kg) for single pipe or multiple landed on top strut.
3. Overhead Pipe Supports:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
4. Plenum Pipe Supports:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
3) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
5. Inserts and Clamps:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
2) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Field-Welding (where approved by Architect): Comply with Section 055000.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

I. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 033000.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

K. Secure fasteners according to manufacturer's recommended torque settings.

L. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 230529

SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration-isolated equipment support bases.

C. Vibration isolators.

D. Vibration-isolated and/or seismically engineered roof curbs.

1.02 RELATED REQUIREMENTS

A. Section 014533 - Code-Required Special Inspections and Procedures.

B. Section 033000 - Cast-in-Place Concrete.

C. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

1.03 DEFINITIONS

1.04 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. MFMA-4 - Metal Framing Standards Publication; 2004.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
   1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.

D. Shop Drawings - Vibration Isolation Systems:
   1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
   2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.

E. Manufacturer’s detailed field testing and inspection procedures.

1.07 QUALITY ASSURANCE

A. Comply with applicable building code.

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

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.

B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:
   1. Select vibration isolators to provide required static deflection.
   2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.

D. Equipment Isolation: As indicated on drawings.

E. Equipment Isolation:
   1. Equipment Type: Roof Top Units and Exhaust Fans.
      a. Location: Outdoor.
      b. Mounting: Vibration-isolated structural steel base.
      c. Isolator Type (Nonseismic Application): Restrained spring isolators.

F. Piping Isolation:
   1. Provide vibration isolators for piping supports:
      a. Located within 50 feet (15.2 m) of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.
      b. For piping over 2 inch (50 mm) located below or within 50 feet (15.2 m) of noise-sensitive areas indicated.
   2. Minimum Static Deflection:
      a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch (50 mm) deflection required.
      b. Remainder of Supports: 0.75 inch (19 mm) deflection unless otherwise indicated.
   3. Suspended Piping, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.

4. Floor-Mounted Piping, Nonseismic Applications: Use open (unhoused) spring isolators.
5. Use modular seal or approved resilient material where vibration-isolated piping penetrates building elements (e.g., walls, floors) arranged to prevent vibration transmission to structure.

2.02 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

A. Manufacturers:
   1. Vibration-Isolated Equipment Support Bases:
      a. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
      b. Mason Industries: www.mason-ind.com/#sle.
      c. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
      d. Vibro-Acoustics: www.vibro-acoustics.com/#sle.

B. Vibration-Isolated Structural Steel Bases:
   1. Description: Engineered structural steel frames with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
   2. Centrifugal Fan Applications: Provide adjustable motor slide rails as required.
   3. Maximum Deflection: 1 inch (25.4 mm).
   4. Color code or otherwise identify springs to indicate load capacity.
   5. Select springs to provide designed deflection of not less than 50 percent of specified deflection.
   6. Products:
      a. Kinetics Noise Control, Inc; QuietRail: www.kineticsnoise.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2.03 VIBRATION ISOLATORS

A. Manufacturers:
   1. Vibration Isolators:
      a. ANDRE HVAC International, Inc: www.andrehvac.com/#sle.
      b. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
      c. Mason Industries: www.mason-ind.com/#sle.
      d. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
      e. Vibro-Acoustics: www.vibro-acoustics.com/#sle.
      f. Substitutions: See Section 016000 - Product Requirements.

B. General Requirements:
   1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
   2. Spring Elements for Spring Isolators:
      a. Color code or otherwise identify springs to indicate load capacity.
      b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
      c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
      d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
      e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
      f. Selected to function without undue stress or overloading.

C. Vibration Isolators for Nonseismic Applications:
   1. Resilient Material Isolator Pads:
      a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material.

b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch (6 mm) thickness.
c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.

2. Open (Unhoused) Spring Isolators:
a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.
b. Bottom Load Plate: Nonskid, molded, elastomeric isolator material or steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
c. Furnished with integral leveling device for positioning and securing supported equipment.

3. Housed Spring Isolators:
a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
d. Furnished with integral leveling device for positioning and securing supported equipment.

4. Restrained Spring Isolators, Nonseismic:
a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
c. Furnished with integral leveling device for positioning and securing supported equipment.
d. Provides constant free and operating height.

2.04 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

A. Manufacturers:
1. Vibration-Isolated and/or Seismically Engineered Roof Curbs:
a. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
b. Mason Industries: www.mason-ind.com/#sle.
c. Vibration Eliminator Company, Inc: www.veco-nyc.com/#sle.
d. Vibro-Acoustics: www.vibro-acoustics.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. Source Limitations: Furnish vibration-isolated roof curbs and associated accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.

B. Vibration Isolation Curbs:
1. Nonseismic Curb Rail:
a. Location: Between existing roof curb and rooftop equipment.
b. Construction: Aluminum.
c. Integral vibration isolation to comply with requirements of this section.
d. Weather exposed components consist of corrosion resistant materials.
2. Nonseismic Curb:

a. Location: Between structure and rooftop equipment.
b. Construction: Aluminum.
c. Integral vibration isolation to comply with requirements of this section.
d. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

E. Vibration Isolation Systems:
1. Vibration-Isolated Equipment Support Bases:
   a. Provide specified minimum clearance beneath base.
2. Spring Isolators:
   a. Position equipment at operating height; provide temporary blocking as required.
   b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
   c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
3. Isolator Hangers:
   a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
   b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
6. Adjust isolators to be free of isolation short circuits during normal operation.
7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect vibration isolation and/or seismic control components for damage and defects.

C. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.

D. Vibration Isolation Systems:

1. Verify isolator static deflections.
2. Verify required clearance beneath vibration-isolated equipment support bases.
3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION 230548

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Pipe markers.

E. Ceiling tacks.

1.02 RELATED REQUIREMENTS

A. Section 099123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2025.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Tags.

C. Dampers: Ceiling tacks, where located above lay-in ceiling.

D. Heat Transfer Equipment: Nameplates.

E. Instrumentation: Tags.

F. Major Control Components: Nameplates.

G. Piping: Pipe markers.

H. Small-sized Equipment: Tags.

I. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Manufacturers:

1. Advanced Graphic Engraving, LLC; _____: www.advancedgraphicengraving.com/#sle.
2. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
3. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
4. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products, a Tricor Direct Company; _____: www.seton.com/#sle.

B. Letter Color: White.

C. Letter Height: 1/2 inch (13 mm).

D. Background Color: Black.

E. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving; _____: www.advancedgraphicengraving.com/#sle.
   2. Brady Corporation; _____: www.bradycorp.com/#sle.
   3. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
   4. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
   5. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
   6. Seton Identification Products, a Tricor Company; _____: www.seton.com/#sle.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

2.04 ADHESIVE-BACKED DUCT MARKERS

A. Manufacturers:
   1. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
   2. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
   3. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.

B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch (0.76 mm); printed with UV and chemical resistant inks.

C. Style: Individual Label.

D. Color: Yellow/Black.

2.05 PIPE MARKERS

A. Manufacturers:
   1. Brady Corporation; _____: www.bradycorp.com/#sle.
   2. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
   3. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
   4. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
   5. Seton Identification Products, a Tricor Company; _____: www.seton.com/#sle.

B. Color: Comply with ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil, 0.004 inch (0.10 mm) thick, manufactured for direct burial service.

F. Color code as follows:
   1. Toxic and Corrosive Fluids: Orange with black letters.
   2. Compressed Air: Blue with white letters.

2.06 CEILING TACKS

A. Manufacturers:
   1. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.

B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

C. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 099123 for stencil painting.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

F. Use tags on piping 3/4 inch (20 mm) diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet (6 m) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

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SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of refrigerating systems.

C. Field quality-control testing of Laboratory fume hoods.

D. Measurement of final operating condition of HVAC systems.

E. Sound measurement of equipment operating conditions.

F. Commissioning activities.

1.02 RELATED REQUIREMENTS

A. Section 012100 - Allowances: Inspection and testing allowances.

B. Section 014000 - Quality Requirements: Employment of testing agency and payment for services.

C. Section 019113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

D. Section 230800 - Commissioning of HVAC.

E. Section 250500 - Common Work Results for Integrated Automation.

1.03 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.

B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016, with Errata.

C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

D. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).

E. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit to the Commissioning Authority.
   3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   4. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   5. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
c. Identification and types of measurement instruments to be used and their most recent calibration date.
d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
e. Final test report forms to be used.
f. Detailed step-by-step procedures for TAB work for each system and issue, including:
    1) Terminal flow calibration (for each terminal type).
    2) Diffuser proportioning.
    3) Branch/submain proportioning.
    4) Total flow calculations.
    5) Rechecking.
    6) Diversity issues.
g. Expected problems and solutions, etc.
h. Details of how TOTAL flow will be determined; for example:
    1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
    2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
i. Specific procedures that will ensure that the air side systems are operating at the lowest possible pressures and methods to verify this.
j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
k. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
l. Method of checking building static and exhaust fan and/or relief damper capacity.
m. Methods for making coil or other system plant capacity measurements, if specified.
n. Time schedule for TAB work to be done in phases (by floor, etc.).
o. Time schedule for deferred or seasonal TAB work, if specified.
p. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
q. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
r. Procedures for formal progress reports, including scope and frequency.
s. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Quality-control Testing of Laboratory Fume Hoods:
    1. Product Data sheets for all equipment proposed for use in on-site as-installed testing.
    2. Sample Test Report.
    3. List of laboratory fume hoods to be tested. Submit a minimum of one week prior to commencement of testing.
    4. Test data demonstrating that each type of fume hood provided for the project has been successfully tested in the factory as per requirements of Section 115313.

E. Field Logs: Submit at least twice a week to the Construction Manager.

F. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

G. Progress Reports.

H. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Revise TAB plan to reflect actual procedures and submit as part of final report.
   2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   5. Units of Measure: Report data in I-P (inch-pound) units only.
   6. Include the following on the title page of each report:
      a. Name of Testing, Adjusting, and Balancing Agency.
      b. Address of Testing, Adjusting, and Balancing Agency.
      c. Telephone number of Testing, Adjusting, and Balancing Agency.
      d. Project name.
      e. Project location.
      f. Project Architect.
      g. Project Engineer.
      h. Project Contractor.
      i. Project altitude.
      j. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. SMACNA (TAB).
   4. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of five years documented experience.
   3. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
      c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 FUME HOOD TESTING (ON SITE)

A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.

B. Testing to be performed by firm certified by National Environmental Balancing Bureau - NEBB (FHT).

C. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.

D. Testing Requirements:
   1. Perform the following tests, in order:
      a. Airflow Velocity Test.
      b. Airflow Visualization Test.
      c. Tracer Gas Containment Test.
   2. If more than one test procedure is selected, proceed to the next test only if any unsafe condition discovered during current test has been successfully rectified.
   3. Airflow Velocity Test: Comply with Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.
   4. Airflow Visualization Test: Comply with Section 10 of NEBB (FHT) Fume Hood Testing Standard - current edition.
   5. Tracer Gas Containment Test:
      a. Comply with Section 11 of NEBB Fume Hood Testing Standard - current edition.
      b. Conduct a static mode test of the hood and laboratory configuration. Conduct testing in accordance with ASHRAE Std 110, except as modified herein:
         1) Test hood with simulated scientific apparatus set-up within the hood. Apparatus to consist of: two (2) each 1 gal. (3.78 L) round paint cans, one (1) 1' by 1' by 1' (305 mm by 305 mm by 305 mm) cardboard box, and three (3) each 6" by 6" by 12" high (152 mm by 152 mm by 305 mm high) cardboard boxes. Position these items from 6 to 10 inches (152 to 254 mm) behind the sash, randomly distributed, and supported off of the work surface by 2 inch by 2 inch by 2 inch (51 mm by 51 mm by 51 mm) block of any material.
         2) 6 liters per minute release rate for tracer gas.
         3) Conduct only at the center position for the manikin.
         4) Each tracer gas test duration to be 5 minutes.
         5) Acceptable test results will be 0.05 PPM or better.
         6) At the conclusion of each 5-minute test there will be three rapid walk-by at 1' (305 mm) behind the manikin. Each walk-by to be spaced 30 seconds apart. If a rise in test gas concentration occurs, it cannot exceed 0.10 ppm and must return to 0.05 ppm within 15 seconds.
         7) There must be a minimum of three and a maximum of five people in the space in which the fume hood is located during the test procedure.
         8) Representatives of the Architect, Engineer, Owner, and Contractor must witness the tests.
         9) Test of Alarm: Shut off the fume hood exhaust and verify that the individual fume hood alarm activates.

10) Test individual controls: Test any controls that are provided at the fume hood such as unoccupied cycle override, alarm override, etc.

c. Conduct a dynamic mode test of the hood to measure performance parameters of fume hood control systems during the following test events:
   1) Sash movement: 25 percent to 100 percent, and 50 percent to 100 percent operating positions.
   2) Rapid walk-by in front of the hood. Conduct only at center position for the manikin.
   3) Opening and closing main space entrance door, to simulate a person entering or exiting the space.

6. Reporting Requirements: Comply with Section 5 of NEBB (FHT) Fume Hood Testing Standard - current edition. Organize and include, at a minimum, the following information:
   a. Report Title.
   b. Report Certification.
   c. Table of Contents.
   d. Report Summary/ Remarks.
   e. Appropriate Forms.
   f. Instrument Calibration.
   g. List of Abbreviations Used.
   h. A room layout drawing for each tested item. Identify: walls; doors; fume hood(s); other present environmental enclosures (e.g. biological safety cabinet(s), laminar flow hood(s), canopy hood(s), etc.); location and airflow pattern of all air supply, return, and exhaust grilles, registers and diffusers.

3.07 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.

M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.08 COMMISSIONING

A. See Sections 019113 - General Commissioning Requirements and 230800 for additional requirements.

B. Perform prerequisites prior to starting commissioning activities.

C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.

D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for all air handling units or as directed by Commissioning Authority.
   1. Use the same test instruments as used in the original TAB work.
   2. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   3. For purposes of re-check, failure is defined as follows:
      a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
      b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
      c. Temperatures: Deviation of more than one degree F (0.5 degree C).
      d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
      e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

F. In the presence of the Commissioning Authority, verify that:
   1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
   2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3.09 SCOPE

A. Test, adjust, and balance the following:
   1. Plumbing Pumps.
   2. Air Cooled Refrigerant Condensers.
   3. Packaged Roof Top Heating/Cooling Units.
   4. Air Coils.

5. Terminal Heat Transfer Units.
6. Air Handling Units.
7. Fans.
8. Air Filters.
9. Air Terminal Units.
10. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:
1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.

C. Pumps:
1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Service.
5. Actual flow rate, pressure drop, BHP.
6. Discharge pressure.
7. Shut off, discharge and suction pressures.
8. Shut off, total head pressure.

D. Combustion Equipment:
1. Model number.
2. Serial number.
3. Burner manifold gas pressure.
4. Ambient temperature.
5. Heat output.

E. Air Cooled Condensers:
1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

F. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Entering air DB temperature, design and actual.
6. Entering air WB temperature, design and actual.
7. Leaving air DB temperature, design and actual.
8. Leaving air WB temperature, design and actual.
9. Saturated suction temperature, design and actual.
10. Air pressure drop, design and actual.

G. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air temperature, design and actual.
7. Leaving air temperature, design and actual.
8. Air pressure drop, design and actual.

H. Electric Duct Heaters:
1. Manufacturer.
2. Identification/number.
3. Location.
4. Model number.
5. Design kW.
6. Number of stages.
7. Phase, voltage, amperage.
8. Test voltage (each phase).
9. Test amperage (each phase).
10. Air flow, specified and actual.
11. Temperature rise, specified and actual.

I. Air Moving Equipment:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

J. Return Air/Outside Air:
1. Identification/location.

2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

K. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

L. Duct Traverses:
1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

M. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
    a. Blower.
    b. Orifice, tube size.
    c. Orifice size.
    d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.

9. Leakage.

N. Air Monitoring Stations:
1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

O. Flow Measuring Stations:
1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

P. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

Q. Air Distribution Tests:
1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

END OF SECTION 230593

SECTION 230713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Weather barrier coatings.

D. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 099113 - Exterior Painting: Painting insulation jackets.

C. Section 099123 - Interior Painting: Painting insulation jackets.

D. Section 230553 - Identification for HVAC Piping and Equipment.

E. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.

F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).

G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

I. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

J. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.

K. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2019.

L. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.

M. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016 (Reapproved 2021).

N. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2019 (Reapproved 2022).

O. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers; 2015 (Reapproved 2022).

P. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation; 2017 (Reapproved 2023).

Q. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.

R. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use Over Thermal Insulation for Outdoor Applications; 2022.

S. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay; 2017 (Reapproved 2021).

T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

U. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

V. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

W. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth; 2016b.

X. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

Y. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

Z. UL 181A - Closure Systems for Use with Rigid Air Ducts; Current Edition, Including All Revisions.

AA. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors; Current Edition, Including All Revisions.

BB. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 10 years of experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville; _____: www.jm.com/#sle.
   3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
   4. Knauf Insulation: www.knaufinsulation.com/#sle.
   5. Owens Corning Corporation; _____: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. K (Ksi) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
   2. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

D. Indoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

E. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville; _____: www.jm.com/#sle.
   3. Knauf Insulation; _____: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
   2. Maximum Water Vapor Absorption: 5.0 percent.
   3. Maximum Density: 8.0 pcf (128 kg/cu m).

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

E. Protective Coating:
   1. Manufacturers:
      a. Design Polymerics; DP 2510 Water Based, Low VOC, Duct Liner Protective Coating: www.designpoly.com/#sle.

F. Indoor Vapor Barrier Finish:
   1. Manufacturers:
   2. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
   3. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
   1. Aeroflex USA; AEROFLEX Breathe-EZ: www.aeroflexusa.com/#sle.
   2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
   2. Maximum Service Temperature: 180 degrees F (82 degrees C).
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.05 WEATHER BARRIER COATINGS

A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
   1. Manufacturers:
      a. H.B. Fuller Construction Products, Inc; Childers - CP Series Weather Barrier Coating: www.fosterproducts.com/#sle.
   2. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
   3. Water Vapor Permeance: Greater than 1.0 perm (57 ng/(Pa s m)) in accordance with ASTM E96/E96M.
   4. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.

2.06 JACKETING AND ACCESSORIES

A. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square (2.45 kg/sq m).

B. Aluminum Jacket:
   1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
   2. Thickness: 0.016 inch (0.40 mm) sheet.
   3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   4. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.

5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

C. Aluminum-Foil Laminate Jacket:
1. Manufacturers:
2. Factory-applied, pressure sensitive adhesive jacketing on paper release liner.
3. Finish: Aluminum smooth.
4. Comply with ASTM C1775.

D. Aluminum-Foil Laminate Jacket:
1. Manufacturers:
a. H.B. Fuller Construction Products, Inc; Foster - Vapor-Fas: www.fosterproducts.com/#sle.
2. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.

E. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
2. Thickness: 34 mil, 0.034 inch (0.86 mm).
3. Finish: Embossed.
4. Color: Silver.
5. Water Vapor Transmission: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
7. Emissivity: 0.30 when tested in accordance with ASTM C1371.
8. Manufacturers:
a. Polyguard Products; Alumaguard: www.polyguardproducts.com.com/#sle.

F. Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723 or ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch (0.00 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
4. Finish: Match insulation.

G. Plain Foil Tape:
1. Manufacturers:
2. Aluminum foil with pressure-sensitive adhesive on paper release liner.
3. Finish: Plain foil.

H. UL181 Tape for Rigid and Flexible Ductwork:
1. Manufacturers:
a. Ideal Tape Co., Inc; _____: www.idealtape.com/#sle.
2. Comply with UL 181A for rigid ductwork.
3. Comply with UL 181B for flexible ductwork.
4. Aluminum foil coated with pressure-sensitive adhesive on paper release liner.
5. Foil tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
6. Finish: Printed with UL Listing for identification.

2.07 DUCT LINER

A. Manufacturers:
1. Aeroflex USA; AEROFLEX Breathe-EZ: www.aeroflexusa.com/#sle.

2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
3. CertainTeed Corporation; _____: www.certainteed.com/#sle.
4. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
5. Johns Manville; _____: www.jm.com/#sle.
6. Owens Corning Corporation; QuietR Rotary Duct Insulation: www.ocbuildingspec.com/#sle.

B. Note: Choose the liner type - Elastomeric Foam, Glass Fiber, or Phenolic Foam.

C. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
2. Maximum Service Temperature: 180 degrees F (82 degrees C).
3. Fungal Resistance: No growth when tested according to ASTM G21.
4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F (0.045 at 24 degrees C).
5. Minimum Noise Reduction Coefficients:
   a. 1/2 inch (13 mm) Thickness: 0.30.
   b. 1 inch (25 mm) Thickness: 0.40.
   c. 1-1/2 inches (40 mm) Thickness: 0.50.
6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm (50.8 m/s) when tested in accordance with ASTM C1071.
7. Connection: Waterproof vapor barrier adhesive.

D. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.

E. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F (0.045 at 24 degrees C).
3. Service Temperature: Up to 250 degrees F (121 degrees C).
4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm (25.4 m/s), minimum.
5. Minimum Noise Reduction Coefficients:
   a. 1/2 inch (13 mm) Thickness: 0.30.
   b. 1 inch (25 mm) Thickness: 0.45.
   c. 1-1/2 inches (40 mm) Thickness: 0.60.

F. Adhesive: Waterproof, fire-retardant type, ASTM C916.
1. Manufacturers:
   a. Design Polymerics; DP 2502 Water Based, Low VOC, Duct Liner Adhesive: www.designpoly.com/#sle.
   b. Elgen Manufacturing Company, Inc; Water Based Liner Adhesive: www.elgenmfg.com/#sle.

G. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.
1. Manufacturers:
   a. Elgen Manufacturing Company, Inc; Peel and Press Insulation Hangers: www.elgenmfg.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated Ducts Conveying Air Below Ambient Temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor) ((below 3 meters above finished floor)): Finish with canvas jacket sized for finish painting.

E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with outdoor jacket finished; see Section _____.

F. Slope exterior ductwork to shed water.

G. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

H. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 90 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
   3. Seal and smooth joints. Seal and coat transverse joints.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. Evaporative Condenser Intake and Exhaust:

B. Exhaust Ducts Within 10 ft (3 m) of Exterior Openings:

C. Exhaust Ducts Exposed to Outdoor Air:

D. Outside Air Intake Ducts:

E. Plenums:

F. Plenums (Cooling System):

G. Ventilation Equipment Casings:

H. Supply Ducts:

I. Supply Ducts From Fans to Vertical Ducts in Shafts (Cooling System):
J. Supply Ducts in Vertical Shafts (Cooling Systems):
K. Supply ducts After Terminal Boxes:
L. Return and Relief Ducts in Mechanical Rooms:
M. Ducts Exposed to Outdoors:

END OF SECTION 230713

SECTION 230800
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 019113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Ductwork and accessories.
   3. Terminal units.
   4. Variable frequency drives.
   5. Special Ventilation:
      a. Fume hoods.
      b. Laboratory pressurization.
      c. Specialty fans.
      d. Egress pressurization.
   6. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

B. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

C. Section 019113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

D. Section 230593 - Testing, Adjusting, and Balancing for HVAC.

E. Section 230913 - Instrumentation and Control Devices for HVAC.

F. Section 230923 - Direct-Digital Control System for HVAC.

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 1.1 - Application of the Commissioning Process to New HVAC&R Systems; 2025.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing each controller after installation, including:
      a. Process of verifying proper hardware and wiring installation.
      b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
      c. Process of performing operational checks of each controlled component.
      d. Plan and process for calibrating valve and damper actuators and all sensors.
      e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
   4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
   5. Description of the instrumentation required for testing.
   6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

C. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
   1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
   2. Full as-built set of control drawings.
   3. Full as-built sequence of operations for each piece of equipment.
   4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
      a. Floor.
      b. Room number.
      c. Room name.
      d. Air handler unit ID.
      e. Reference drawing number.
      f. Air terminal unit tag ID.
      g. Heating and/or cooling valve tag ID.
      h. Minimum air flow rate.
      i. Maximum air flow rate.
   5. Full print out of all schedules and set points after testing and acceptance of the system.
   6. Full as-built print out of software program.
   7. Electronic copy on disk of the entire program for this facility.
   8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.

9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
    a. Sequences of operation.
    b. Control drawings.
    c. Points lists.
    d. Controller and/or module data.
    e. Thermostats and timers.
    f. Sensors and DP switches.
    g. Valves and valve actuators.
    h. Dampers and damper actuators.
    i. Program setups (software program printouts).

E. Project Record Documents: See Section 017800 for additional requirements.
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

F. Draft Training Plan: In addition to requirements specified in Section 017900, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
2. Control system manufacturer's recommended training.
3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.

G. Training Manuals: See Section 017900 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, 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 open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. All control strategies and sequences not tested during controlled equipment testing.
   14. Trend logging and graphing features that are specified.
   15. Other integrated tests specified in Contract Documents

16. That control system features that are included but not specified to be setup are actually installed.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 017800 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 017900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

E. TAB Review: Instruct Owner's personnel for minimum ____ hours, after completion of TAB, on the following:
   1. Review final TAB report, explaining the layout and meanings of each data type.
   2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
   4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
   5. Other salient information that may be useful for facility operations, relative to TAB.

F. HVAC Control System Training: Perform training in at least three phases:
   1. Phase 1 - Basic Control System: Provide minimum of ____ hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
      a. This training may be held on-site or at the manufacturer's facility.
      b. If held off-site, the training may occur prior to final completion of the system installation.
      c. For off-site training, Contractor shall pay expenses of up to two attendees.

2. Phase 2 - Integrating with HVAC Systems: Provide minimum of ____ hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
   a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
   b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
   c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
   d. Every display screen, allowing time for questions.
   e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of ____ hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

G. Provide the services of manufacturer representatives to assist instructors where necessary.

H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION 230800

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SECTION 230913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control panels.

B. Dampers.

C. Damper Operators:
   1. Electric operators.
   2. Inlet vane operators.

D. Wall-, Surface-, and Duct-Mounted Sensors:
   1. Temperature sensors.
   2. Humidity sensors.
   3. Building static pressure transmitters.
   4. Room pressure monitors.
   5. Air pressure transmitters.
   6. Airflow meters; pitot tubes.
   7. Airflow meters; thermal dispersion.
   8. Oxygen Depletion sensors.
   9. Hydrogen Level sensors.

E. Thermostats:
   1. Electric thermostats.
   2. Freezestats.
   3. Room-mount thermostat accessories.
   4. Outdoor-reset thermostats.

F. Fan and pump motor run-status monitoring.

1.02 RELATED REQUIREMENTS

A. Section 230519 - Meters and Gauges for HVAC Piping: Thermometer sockets and gauge taps.

B. Section 233300 - Air Duct Accessories.

C. Section 253513 - Integrated Automation Actuators and Operators.

D. Section 253519 - Integrated Automation Control Valves.

E. Section 253523 - Integrated Automation Control Dampers.

F. Section 253619 - Integrated Automation Current Sensors.

G. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

H. Section 262726 - Wiring Devices: Elevation of exposed components.

1.03 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. ANSI C12.1 - Electric Meters - Code for Electricity Metering; 2024.

C. ANSI C12.10 - American National Standard for Physical Aspects of Watthour Meters - Safety Standard; 2011 (Reaffirmed 2021).

D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.

E. FieldComm Group (FFTS) - Foundation Fieldbus Technical Specifications; 2014.

F. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

G. IEEE 802.3 - IEEE Standard for Ethernet; 2022 (Corrigendum 2024).

H. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020, with Amendment (2023).

I. LonMark Interoperability Guide - LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4; 2005.

J. Modbus (PS) - The Modbus Organization Communications Protocol.; Latest Update.

K. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

L. NEMA BS 31032 - Residential Controls–Electrical Wall-Mounted Room Thermostats; 2025.

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

O. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

P. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Manufacturer's Instructions: Provide for all manufactured components.

E. Designer's qualification statement.

F. Installer's qualification statement.

G. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

H. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience approved by manufacturer.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective work within a five year period after Substantial Completion.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA EN 10250, general purpose utility enclosures with enameled finished face panel.

C. Provide common keying for all panels.

2.03 DAMPERS

A. See Section 233300 for dampers and this section for actuators and operators.

2.04 DAMPER OPERATORS

A. General:
   1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
   2. Provide spring return for two position control and for fail safe operation.
   3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
   4. Provide one operator for maximum 36 sq ft (3.34 sq m) damper section.
   5. See Section 253513 for field-mount damper actuators and operators.

B. Electric Operators:
   1. Manufacturers:
      a. Honeywell International, Inc; _____: buildingcontrols.honeywell.com/#sle.

C. Inlet Vane Operators:
   1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

2.05 WALL-, SURFACE-, AND DUCT-MOUNT SENSORS

A. Temperature Sensors:
   1. Manufacturers:
      a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
      b. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.
      c. Veris Industries; _____: www.veris.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.

2. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
3. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F (26 degrees C).
4. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
5. Temperature Sensing Device: Compatible with project DDC controllers.
6. Performance Characteristics:
    a. RTD:
        1) Room Sensor Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
        2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
        3) Chilled Water Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
        4) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
        5) Range: Minus 40 degrees F (Minus 40 degrees C) through 220 degrees F (104.4 degrees C) minimum.
    b. Thermistor:
        1) Accuracy (All): Plus/minus 0.36 degrees F (0.20 degrees C) minimum.
        2) Range: Minus 25 degrees F (Minus 13 degrees C) through 122 degrees F (50 degrees C) minimum.
        3) Heat Dissipation Constant: 2.7 mW per degree C.
    c. Temperature Transmitter:
        1) Accuracy: 0.10 degree F (0.06 degrees C) minimum or plus/minus 0.20 percent of span.
        2) Output: 4 to 20 mA.
    d. Sensing Range:
        1) Provide limited range sensors if required to sense the range expected for a respective point.
        2) Use RTD type sensors for extended ranges beyond minus 30 to 230 degrees F (minus 34.4 to 114.4 degrees).
        3) Use temperature transmitters in conjunction with RTDs when RTDs are incompatible with DDC controller direct temperature input.
    e. Wire Resistance:
        1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F (0.56 degrees C) or use temperature transmitter when offset is greater than 1.0 degree F (0.56 degrees C) due to wire resistance.
        2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
    f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
    g. Room Temperature Sensors:
        1) Construct for surface or wall box mounting.
    h. Room Temperature Sensors with Integral Digital Display:
        1) Construct for surface or wall box.
        2) Provide a four button keypad with the following capabilities:
            (a) Indication of space and outdoor temperatures.
            (b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, and Sequence of Operation.
            (c) Display and control fan operation status.
            (d) Manual occupancy override and indication of occupancy status.
            (e) Controller mode status.

(f) Password enabled setpoint and override modes.

B. Humidity Sensors, Outdoor-Mount:
1. Manufacturers:
a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
b. Veris Industries; _____: www.veris.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Digitally profiled thin-film capacitive sensor encased in a die-cast metal, weather-proof plastic or metal housing with solar shield.
3. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
5. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
6. Temperature Sensor, Combined: Platinum RTD.
a. Transmitter: Fitted within device-interface enclosure, calibrated.
b. Monitoring Range: Minus 40 to 122 degrees F (Minus 40 to 50 degrees C), adjustable.
c. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
d. Accuracy: Plus/minus three percent. Adjustable on the transmitter end.
7. Service Humidity: 0 to 100 percent RH, noncondensing.

C. Humidity Sensors, Duct-Mounted:
1. Manufacturers:
a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
b. Veris Industries; HD Series: www.veris.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Digitally profiled thin-film capacitive sensor probe extended from die-cast metal, weather-proof plastic or metal housing designed for duct mounting.
3. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
5. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
6. Temperature Sensor, Combined: Platinum RTD.
a. Transmitter: Fitted within device-interface enclosure, calibrated.
b. Monitoring Range: 32 to 122 degrees F (0 to 50 degrees C), adjustable.
c. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
d. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
7. Service Humidity: 0 to 100 percent RH, noncondensing.

D. Building Static Pressure Transmitters:
1. Manufacturers:
a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
b. Setra Systems, Inc; _____: www.setra.com/#sle.
c. Veris Industries; _____: www.veris.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.
2. Single port for direct or tubing connection into wall or ceiling static pressure tip, direct acting, double bell, scale range 0.01 to 6.0 in-wc (.0025 to 1.5 kPa) positive or negative, and sensitivity of 0.0005 in-wc (0.125 Pa). Transmit electronic signal to receiver with matching scale range.

E. Room Pressure Monitors:
1. Manufacturers:

a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
b. Ebtron, Inc; _____: www.ebtron.com/#sle.
c. Setra Systems, Inc; _____: www.setra.com/#sle.
d. Veris Industries; _____: www.veris.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

2. Type: Externally powered, remote differential pressure transmitter interconnected via tubing or cables to pick-up sensors located inside wall-section fitted module(s).
3. Transmitter: Five percent accuracy, adjustable zero and span, 100 to 1 turndown, 0.1 percent of calibrated span linearity, 30 to 50 millisecond response time, minimum overpressure of 150 percent over highest range value, alphanumeric indicating display, wired or wireless connectivity for configuration, and terminal strip within enclosed electronic components.
4. Differential Pressure Monitoring Range: 0 to 0.05 in-wc (0 to 12.4 Pa), bidirectional.
5. Temperature Monitoring Range: 32 to 104 degrees F (0 to 40 degrees C).
6. BAS, SCADA, or other Integrated Automation System Output: Two-wire, 4 to 20 mA.

F. Air Pressure Transmitters:
1. Manufacturers:
a. Veris Industries; PX3 Series: www.veris.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
2. General: Provide dry air media, differential pressure transducers to monitor duct and room pressure.
3. Accuracy: Plus/minus 2 percent full scale of range with combined linearity and hysteresis.
4. Zero Adjust: Pushbutton auto-zero and digital input using 2-position terminal block.
5. Measuring Range: 1 to 10 in-wc (250 to 2500 Pa), unidirectional or bidirectional.
6. Response Time: 2 seconds, adjustable.
7. Hardwired Output: 2-wire, loop-powered 4 to 20 mA, field selectable.
8. Service Temperature: 32 to 122 degrees F (0 to 50 degrees C).
9. Fittings: Brass barb, UL 94 V-O fire retardant ABS, 0.24 inches (6.1 mm) outer diameter.

G. Airflow Meters; Pitot Tubes:
1. Manufacturers:
a. Air Monitor, a brand of Onicon, Inc; VOLU-flo/OAM-II: www.onicon.com/#sle.
b. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
c. KMC Controls; Conquest Airflow Measurement System: www.kmccontrols.com/#sle.
d. Paragon Controls, Inc; _____: www.paragoncontrols.com/#sle.
e. Ruskin Company; _____: www.ruskin.com/#sle.
f. Substitutions: See Section 016000 - Product Requirements.
2. Sensor Type: Provide duct-inserted probe, duct-inserted pitot-tube assembly, and wall-mounted assembly for outside air with built-in transmitter.
3. Flow Range: Equivalent velocity pressure required to match scheduled flow range with a 100 to 1 signal turndown ratio.
4. Accuracy: Two percent over a 30 to 50 millisecond response time, adjustable.
5. Linearity: 0.1 percent of calibrated span.
6. Minimum Overpressure: 150 percent over highest range value.
7. Output: Two-wire, 4 to 20 mA.
8. Access Box: NEMA EN 10250, Type 1 with hinged cover housing and cable access ports.

H. Airflow Meters; Thermal Dispersion:
1. Manufacturers:
a. Air Monitor, a brand of Onicon, Inc; ELECTRA-Flo Series: www.onicon.com/#sle.

b. Ebtron, Inc; _____: www.ebtron.com/#sle.
c. Greystone Energy Systems, Inc; _____: www.greystoneenergy.com/#sle.
d. Ruskin Company; _____: www.ruskin.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

2. Configuration: Duct or plenum inserted assembly using up to eight water-resistant thermal dispersion sensors per metal probe wired into external access box holding self-diagnosing sensor interface electronics with respective field wire and cable landing terminals.
3. Provide thermal dispersion flow meters complete with matched transducers, self aligning installation hardware, and transducer cables.
4. Optimize thermal dispersion transducer for the specific duct or pipe and process conditions for the application.
5. Signal Monitoring Range:
   a. Air Velocity: 0 to 2000 fpm (0 to 10.1 m/s), bidirectional converted to airflow using section area and air velocity from listed range.
   b. Temperature: 32 to 104 degrees F (0 to 40 degrees C).
   c. Humidity: 5 to 95 percent RH, noncondensing.
6. Accuracy: Plus or minus 1 percent, NIST with a plus or minus 0.25 percent repeatability over listed range. Include means to zero, adjust, and calibrate outputs.
7. Access Box: NEMA EN 10250, Type 1 with hinged cover housing and cable access ports.
8. Outputs: Two-wire, 4 to 20 mA, for each measured signal, configurable.

I. Oxygen Depletion (O2) Sensor:
1. Manufacturers:
   a. Greystone Energy Systems, Inc; _____: www.greystoneenergy.com/#sle.
   b. Macurco, a brand or Aerionics, Inc; _____: www.macurco.com/#sle.
   c. Veris Industries; GWN Series with AG04 Sensor: www.veris.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.
2. Gas sensing module that holds fixed or replaceable oxygen gas-sensor cartridge.
3. Form Factor: IEC 60529, IP20 enclosure, single-gang electrical box mounted.
4. Electromechanical sensor with 0 to 500 ppm measurement range.
5. Accuracy: Plus/minus Five percent of range with 1 ppm resolution.
6. Hardwired Output: Three-wire, 4 to 20 mA, loop powered.

J. Hydrogen Level Sensors, Wall:
1. Manufacturers:
   a. Greystone Energy Systems, Inc; _____: www.greystoneenergy.com/#sle.
   b. Macurco, a brand or Aerionics, Inc; _____: www.macurco.com/#sle.
   c. Veris Industries; _____: www.veris.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.
2. General: Provide Electrical Resistance Hydrogen sensors with integral transducers and linear output.
3. Air Temperature: Range of 32 to 122 degrees F (0 to 50 degrees C).
4. Relative Humidity: Range of 0 to 95 percent (noncondensing).
5. Calibration Characteristics:
   a. Automatically compensating algorithm for sensor drift due to sensor degradation.
   b. Maximum Drift: 2 percent.
   c. User calibratable with a minimum calibration interval of 5 years.
6. Construction:
   a. Sensor Chamber: Noncorrosive material with palladium coated sensor.
   b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.

c. Housing: High impact plastic.

2.06 THERMOSTATS

A. Electric Thermostats:
1. Manufacturers:
a. Honeywell International, Inc; _____: buildingcontrols.honeywell.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
2. Type: NEMA BS 31032, 24 volts, with setback/setup temperature control.
3. Service: Cooling and heating.
4. Covers: Locking with set point adjustment, with thermometer.

B. Freezestats:
1. Manufacturers:
a. Honeywell International, Inc; _____: buildingcontrols.honeywell.com/#sle.
b. Veris Industries; TZ Series: www.veris.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.
2. Configuration: Vapor-filled capillary.
3. Probe Sensing Length: 20 feet (6.1 m).
4. Setpoint Adjust Control: Screw with manual reset switch.
5. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
6. Mounting: Locate on cooling coil intake side.
7. Field Interface: Connect load line-voltage to starter.
8. Electrical Rating: As indicated on drawings.

C. Room-Mounted Thermostat Accessories:
1. Thermostat Covers: Brushed aluminum.
2. Insulating Bases: For thermostats located on exterior walls.

2.07 FAN AND PUMP MOTOR RUN-STATUS MONITORING

A. Current Switches:
1. Manufacturers:
a. Automation Components, Inc; _____: www.workaci.com/#sle.
b. Functional Devices, Inc; _____: www.functionaldevices.com/#sle.
c. Schneider Electric; _____: www.schneider-electric.us/#sle.
d. Veris Industries; H3xx, Micro Split-Core Series: www.veris.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.
2. Micro-Split Core: 2-state, On/Off digital output of motor status.
3. Mini Split-Core: 2-state, On/Off digital output of inverter-duty motor status with adjustable trip point to detect belt loss or mechanical failure.
4. Maximum AC Current Monitoring Value: As indicated on drawings.

B. Current Transducers: See Section 253619 for analog output, current monitoring devices.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

F. Ensure installation of components is complementary to installation of similar components.

G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches (1500 mm) above floor. Align with lighting switches and humidistats; see Section 262726.

C. Mount freeze protection thermostats using flanges and element holders.

D. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

E. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

F. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

C. Provide service and maintenance of control system for one year from Date of Substantial Completion.

D. Provide complete service of controls systems, including call backs, and submit written report of each service call.

E. In addition to normal service calls, make minimum of ____ complete normal inspections of approximately ____ hours duration to inspect, calibrate, and adjust controls.

3.04 SCHEDULES

A. Control Damper Schedule
   1. Drawing Code
   2. Height
   3. Width
   4. Airflow
   5. Air Pressure Drop

END OF SECTION 230913

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SECTION 230923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System description.
B. Operator interface.
C. Controllers.
D. Power supplies and line filtering.
E. System software.
F. Controller software.
G. HVAC control programs.

1.02 RELATED REQUIREMENTS

A. Section 230913 - Instrumentation and Control Devices for HVAC.
B. Section 230993 - Sequence of Operations for HVAC Controls.
C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.
D. Section 275313 - Clock Systems.
E. Section 281000 - Access Control.
F. Section 283111 - Building Intrusion Detection.
G. Section 284600 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.
B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems; 2019, with Addendum (2024).
C. CTA-709.1 - Control Network Protocol Specification; 2019.
D. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020, with Amendment (2023).
E. LonMark Interoperability Guide - LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4; 2005.
F. LonMark SCPT List - LonMark SCPT Master List; Version 15; 2014.
G. LonMark SNVT List - LonMark SNVT Master List; Version 15; 2014.
H. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2022h, with Editorial Revision.
I. Modbus (PS) - The Modbus Organization Communications Protocol.; Latest Update.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
K. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:
   1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List connected data points, including connected control unit and input device.
   3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
   4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   5. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Manufacturer's Qualification Statement.

F. Installer's Qualification Statement.

G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include submittals data in final "Record Documents" form.

H. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

J. Maintenance Materials:
   1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

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

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

E. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.

F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Substantial Completion.

C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.08 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Honeywell International, Inc; _____: www.honeywell.com/#sle.

B. Substitutions: See Section 016000 - Product Requirements.

2.02 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 230913.

E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

A. PC Based Work Station:
   1. Resides on high speed network with building controllers.
   2. Connected to server for full access to all system information.

B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.

C. BACnet protocol to comply with ASHRAE Std 135.

D. Hardware:

1. Desktop:
   a. Computer(s) and display(s) to be provided by DDC controls manufacturer.
   b. Quantity: As indicated on the drawings.
   c. Minimum RAM: _____.
   d. Minimum Processing Speed: _____.
   e. Minimum Hard Drive Memory: _____.
   f. Drives: _____.
   g. Ports: _____.
   h. Monitor: _____.
   i. Location(s): As indicated on the drawings.
   j. Network Connection:
      1) Ethernet interface card.
      2) Minimum Speed: _____.
   k. System Printer:
      1) Printer(s) to be provided by DDC controls manufacturer.
      2) Quantity: As indicated on the drawings.
      3) Type: _____.
      4) Resolution: _____.
      5) Minimum Print Speed: _____.
      6) Locations(s): As indicated on the drawings.

2.04 CONTROLLERS

A. Building Controllers:
   1. General:
      a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
      b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
      c. Share data between networked controllers.
      d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
      e. Utilize real-time clock for scheduling.
      f. Continuously check processor status and memory circuits for abnormal operation.
      g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
      h. Communication with other network devices to be based on assigned protocol.
   2. Communication:
      a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
      b. Perform routing when connected to a network of custom application and application specific controllers.
      c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
   3. External Input-Output (I-O) Data Bus:
      a. Input only modules.
      b. Output only modules.
      c. Variable frequency drives (VFD's).
      d. Universal I-O module (configurable).
      e. Specific wired data integration modules.

f. DALI (Digital addressable lighting interface) modules.
g. Multiple Input Output (I-O) Module:
1) IAQ: Temperature, humidity, and CO2.
2) Audio: Microphone, tone generator, and speaker.
3) Input and output terminals to monitor or control local devices.
4) Occupancy: Light and thermal sensing with multi-colored LED feedback.

4. Anticipated Environmental Ambient Conditions:
a. Outdoors and/or in Wet Ambient Conditions:
1) Mount within waterproof enclosures.
2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

5. Provisions for Serviceability:
a. Diagnostic LEDs for power, communication, and processor.
b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

7. Power and Noise Immunity:
a. Maintain operation at 90 to 110 percent of nominal voltage rating.
b. Perform orderly shutdown below 80 percent of nominal voltage.
c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).

B. Custom Application Controller:
1. General:
a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
b. Share data between networked, microprocessor based controllers.
c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
d. Utilize real-time clock for scheduling.
e. Continuously check processor status and memory circuits for abnormal operation.
f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
g. Communication with other network devices to be based on assigned protocol.

2. Communication:
a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:
a. Outdoors and/or in Wet Ambient Conditions:
1) Mount within waterproof enclosures.
2) Rated for operation at 40 to 150 degrees F (4 to 65 degrees C).
b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

4. Provisions for Serviceability:
   a. Diagnostic LED's for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet (1 m).

C. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.
   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
      1) VAV terminal units.

2) Duct mounted heating coils.

c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
   1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
   2. Limit connected loads to 80 percent of rated capacity.
   3. Match DC power supply to current output and voltage requirements.
   4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
   5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
   6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
   7. Operational Ambient Conditions: 32 to 120 degrees F (0 to 50 degrees C).
   8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
   9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
   1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
   2. Minimum surge protection attributes:
      a. Dielectric strength of 1000 volts minimum.
      b. Response time of 10 nanoseconds or less.
      c. Transverse mode noise attenuation of 65 dB or greater.
      d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.06 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 19.2 Kb.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.07 SYSTEM SOFTWARE

A. Operating System:
   1. Concurrent, multi-tasking capability.
      a. Common Software Applications Supported: Microsoft Excel and Microsoft Access.
      b. Acceptable Operating Systems: _____.
   2. System Graphics:
      a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
      b. Animation displayed by shifting image files based on object status.
      c. Provide method for operator with password to perform the following:
         1) Move between, change size, and change location of graphic displays.
         2) Modify on-line.
         3) Add, delete, or change dynamic objects consisting of:
            (a) Analog and binary values.
            (b) Dynamic text.
            (c) Static text.
            (d) Animation files.
   3. Custom Graphics Generation Package:
      a. Create, modify, and save graphic files and visio format graphics in PCX formats.
      b. HTML graphics to support web browser compatible formats.
      c. Capture or convert graphics from AutoCAD.
   4. Standard HVAC Graphics Library:
      a. HVAC Equipment:
         1) Air Handlers.
         2) Terminal HVAC Units.
      b. Ancillary Equipment:
         1) Fans.
         2) Pumps.
         3) Dampers.
         4) Ductwork.
      c. File Format Compatible with Graphics Generation Package Program.

B. Workstation System Applications:
   1. Automatic System Database Save and Restore Functions:
      a. Current database copy of each Building Controller is automatically stored on hard disk.
      b. Automatic update occurs upon change in any system panel.
      c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
   2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
      a. Save database from any system panel.
      b. Clear a panel database.
      c. Initiate a download of a specified database to any system panel.
   3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
   4. On-line Help:
      a. Context-sensitive system assists operator in operation and editing.
      b. Available for all applications.
      c. Relevant screen data provided for particular screen display.

d. Additional help available via hypertext.

5. Security:
   a. Operator log-on requires user name and password to view, edit, add, or delete data.
   b. System security selectable for each operator.
   c. System supervisor sets passwords and security levels for all other operators.
   d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
   e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
   f. All system security data stored in encrypted format.
6. System Diagnostics:
   a. Operations Automatically Monitored:
      1) Workstations.
      2) Printers.
      3) Modems.
      4) Network connections.
      5) Building management panels.
      6) Controllers.
   b. Device failure is annunciated to the operator.
7. Alarm Processing:
   a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
   b. Configurable Objects:
      1) Alarm limits.
      2) Alarm limit differentials.
      3) States.
      4) Reactions for each object.
8. Alarm Messages:
   a. Descriptor: English language.
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
   f. Paging.
   g. Providing audible annunciation.
   h. Displaying specific system graphics.
10. Custom Trend Logs:
    a. Definable for any data object in the system including interval, start time, and stop time.
    b. Trend Data:
       1) Sampled and stored on the building controller panel.
       2) Archivable on hard disk.
       3) Retrievable for use in reports, spreadsheets and standard database programs.

4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
    a. View all system alarms and change of states from any system location.
    b. Events listed chronologically.
    c. Operator with proper security acknowledges and clears alarms.
    d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
    a. Provide a method to view, edit if applicable, the status of any object and property in the system.
    b. Status Available by the Following Methods:
        1) Menu.
        2) Graphics.
        3) Custom Programs.
13. Reports and Logs:
    a. Reporting Package:
        1) Allows operator to select, modify, or create reports.
        2) Definable as to data content, format, interval, and date.
        3) Archivable to hard disk.
    b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
    c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
    d. Set to be printed on operator command or specific time(s).
14. Reports:
    a. Standard:
        1) Objects with current values.
        2) Current alarms not locked out.
        3) Disabled and overridden objects, points and SNVTs.
        4) Objects in manual or automatic alarm lockout.
        5) Objects in alarm lockout currently in alarm.
        6) Logs:
            (a) Alarm History.
            (b) System messages.
            (c) System events.
            (d) Trends.
    b. Custom:
        1) Daily.
        2) Weekly.
        3) Monthly.
        4) Annual.
        5) Time and date stamped.
        6) Title.
        7) Facility name.
    c. Tenant Override:
        1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
        2) Annual report showing override usage on a monthly basis.

d. Electrical, Fuel, and Weather:
    1) Electrical Meter(s):
        (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
        (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
    2) Fuel Meter(s):
        (a) Monthly showing daily natural gas consumption for each meter.
        (b) Annual summary showing monthly consumption for each meter.
    3) Weather:
        (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:
1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
    a. Configuration.
    b. Name.
    c. Control parameters.
    d. Set-points.
4. Scheduling:
    a. Monthly calendar indicates schedules, holidays, and exceptions.
    b. Allows several related objects to be scheduled and copied to other objects or dates.
    c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
    a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
    b. Programming Features:
        1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
        2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
        3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
        4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
        5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
        6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
        7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
        8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.08 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:
   1. User access secured via user passwords and user names.
   2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
   3. User Log On/Log Off attempts are recorded.
   4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:
   1. Weekly Schedules Based on Separate, Daily Schedules:
      a. Include start, stop, optimal stop, and night economizer.
      b. 10 events maximum per schedule.
      c. Start/stop times adjustable for each group object.
   2. Exception Schedules:
      a. Based on any day of the year.
      b. Defined up to one year in advance.
      c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
   3. Holiday or Special Schedules:
      a. Capability to define up to 99 schedules.
      b. Repeated annually.
      c. Length of each period is operator defined.

D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

E. Alarms:
   1. Binary object is set to alarm based on the operator specified state.
   2. Analog object to have high/low alarm limits.
   3. All alarming is capable of being automatically and manually disabled.
   4. Alarm Reporting:
      a. Operator determines action to be taken for alarm event.
      b. Alarms to be routed to appropriate workstation.
      c. Reporting Options:
         1) Start programs.
         2) Logged.
         3) Custom messaging.
         4) Graphical displays.
         5) Dial out to workstation receivers via system protocol.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 230993.

H. PID Control Characteristics:
   1. Direct or reverse action.

2. Anti-windup.
3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
4. User selectable controlled variable, set-point, and PED gains.

I. Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
2. Provides operator with capability to assign high run-time alarm.

2.09 HVAC CONTROL PROGRAMS

A. General:
1. Support Inch-pounds and SI (metric) units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
6. Operator commands:
   a. Define term schedule.
   b. Add/delete fan status point.
   c. Add/delete outside air temperature point.
   d. Define heating/cooling parameters.
   e. Request optimal run time control summary.
   f. Request HVAC point summary.
   g. Request HVAC saving profile summary.
7. Control Summary:
   a. HVAC Control system begin/end status.
   b. Heating/cooling mode status.

c. Optimal run time schedule.
d. Start/Stop times.
e. Optimal run time system normal start times.
f. Occupancy and vacancy times.
g. Optimal run time system heating/cooling mode parameters.

8. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Calculated optimal start and stop times.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.
3. Operator commands:
   a. Add/delete fan status point.
   b. Request HVAC point summary.
   c. Define discharge controller parameters.
   d. Add/delete air flow rate.
   e. Define space load and load parameters.
   f. Request space load summary.
4. Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Deadband.
   g. Response timer.
   h. Reset times.
5. Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.
   j. Control discharge temperature point ID and status.
   k. Space load point ID and status.
   l. Air flow rate point ID and status.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 230993.

C. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.

C. Provide basic operator training for 3 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

3.05 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

D. Provide complete service of systems, including call backs. Make minimum of 40 hours complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.06 SCHEDULES

A. Input/Output Schedule:
   1. Point Description:
   2. Inputs:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure:
      d. Flow:
      e. Level:
      f. Position:
      g. Energy:
      h. Power:
   3. Outputs:

a. Status:
b. Alarm:
c. Electronic Position:
d. Start/Stop:
e. Off/Low/High:

4. Software Features:
a. PID Control (DDC):
b. High Limit:
c. Low Limit:
d. Run Time Totalization:
e. Consumption Totalization:
f. Program Start/Stop:
g. Optimal Run Time:
h. Supply Air Reset:
i. O.A. Interlock:
j. O.A. Temperature Reset:

B. Alarm Schedule:
1. High Limit: A1.
2. Low Limit: A2.
3. Run Time: A3.
4. Maintenance: A4.
5. Status: A5.
6. Override: A6.
7. Freeze: A7.
8. Low Pressure: A8.

END OF SECTION 230923

SECTION 230934
VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

B. Section 230553 - Identification for HVAC Piping and Equipment: Identification products and requirements.

C. Section 260526 - Grounding and Bonding for Electrical Systems.

D. Section 260573 - Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

E. Section 262813 - Fuses.

F. Section 284600 - Fire Detection and Alarm: For interface with variable-frequency motor controllers.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

E. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

F. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

G. NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.

H. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).

I. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).

J. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

K. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

L. NEMA MG 00001 - Motors and Generators; 2024.

M. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

P. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

Q. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

R. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
2. Include wiring diagrams showing factory and field connections.
3. Identify mounting conditions required for equipment seismic qualification.

C. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Manufacturer qualification statement.

F. Installer qualification statement.

G. Manufacturer's certification that products meet or exceed specified requirements.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Source quality control test reports.

J. Manufacturer’s detailed field testing procedures.

K. Field quality control test reports.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
1. Include contact information for entity providing contract maintenance and trouble call-back service.

M. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
   1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
   2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain copy of each referenced document that prescribes execution requirements at project site.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB: www.abb.com/#sle.

B. Danfoss: www.danfoss.com/#sle.

C. Substitutions: See Section 016000 - Product Requirements.

D. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller, nonbypass.
   2. Power Conversion System: Diode-based, 6-pulse type.
   3. Control Method: Vector; open-loop, without feedback.

D. Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA IS 10035, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

G. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

H. Power Conversion System: Microprocessor-based, pulse width modulation type.

I. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
         1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
         2) Vector Control: Provide selectable autotuning function.
      b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
      c. Selectable braking control; DC injection or flux braking.
      d. Adjustable minimum/maximum speed limits.
      e. Adjustable pulse width modulation switching carrier frequency.
      f. Adjustable motor slip compensation.
      g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
      h. Automatic response to loss of speed reference; selectable to run motor at last known speed, run motor at designated speed, or stop motor.

i. PID Control: Provide integral PID controller employing feedback for closed-loop control where indicated or required.
j. Automatic catching of rotating motor.
k. Safety Interlock: Provide permissive run safety interlock capability where indicated or required; upon activation of designated input, stop and prevent operation of motor; operational in both drive and bypass modes where applicable.

4. Status Indications:
   a. Motor run/stop status.
   b. Motor forward/reverse status.
   c. Local/remote control status.
   d. Output voltage.
   e. Output current.
   f. Output frequency.
   g. DC bus voltage.
   h. Motor speed.
5. Protective Functions/Alarm Indications:
   a. Overcurrent.
   b. Motor overload.
   c. Undervoltage.
   d. Overvoltage.
   e. Controller overtemperature.
   f. Input/output phase loss.
   g. Output short circuit protection.
   h. Output ground fault protection.
6. Inputs:
   a. Digital Input(s): Three.
   b. Analog Input(s): Two.
7. Outputs:
   a. Relay Output(s): Two.
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
   b. Remote Monitoring Capabilities:
      1) Motor run/stop status.
      2) Fault information.
      3) Analog input/output values.
   c. Remote Control Capabilities:
      1) Motor run/stop command.
      2) Speed adjustment.
      3) Fault reset.
9. Features:
   a. Password-protected security access.
   b. Event log.

J. Power Conditioning/Filtering:
   1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
   2. Provide LCL filter for IGBT-based active front end controllers.
   3. Provide input surge protection.
   4. Provide where indicated:

a. Input/line reactor.
b. Input tuned passive filter.
c. Output/load reactor.
d. Output dV/dt filter.
e. Output sine wave filter.

5. Reactor Impedance: 3 percent, unless otherwise indicated or required.

K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.
3. Pilot Devices Required:
a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.

L. Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
a. Altitude: Less than 3,300 feet (1,000 m).
b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

M. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:
1. Comply with NEMA IA 10030.
2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
a. Indoor Clean, Dry Locations: Type 1 or Type 12.
b. Outdoor Locations: Type 3R or Type 4.
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

P. Interface with Other Work:
1. Provide products compatible with other systems requiring interface with controllers.
2. Interface with fire alarm control system as specified in Section 284600.
a. Capable of affecting operation of selected HVAC equipment for selected fire alarm system events.
3. Interface with Existing Work: _____.

Q. Products:
1. ABB; ACH580: www.abb.com/#sle.
2. Danfoss; VLT HVAC Drive FC 102: www.danfoss.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Comply with NEMA ICS 2.
3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
4. Trip-free operation.
5. Visible trip indication.
6. Resettable:
a. Employ manual reset unless otherwise indicated.
b. Do not employ automatic reset with two-wire control.
7. Solid State Overload Relays:
a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
b. Adjustable full load current.
c. Phase loss protection.
d. Phase imbalance protection.
e. Ambient temperature insensitive.
f. Thermal memory.
g. Trip test function.
h. Provide isolated alarm contact.

B. Fusible Disconnect Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated or as required.
2. Fuse Clips: As required to accept indicated fuses.
3. Provide externally operable handle with means for locking in OFF position. Provide means for locking switch cover in closed position. Provide safety interlock to prevent opening of cover with switch in ON position with capability of overriding interlock for testing purposes.

C. Circuit Breakers:
1. Motor Circuit Protectors:
a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of listed combination motor controller with overload protection; ratings, configurations, and features as indicated or as required.
b. Provide field-adjustable magnetic instantaneous trip setting.
c. Provide following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA IA 10039.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.

B. Pilot Devices:
1. Comply with NEMA IA 10039; heavy-duty type.
2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

2.05 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA IS 10034 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 230529.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 260526.

H. Install field-installed devices, components, and accessories.

I. Provide fuses complying with Section 262813 for fusible switches as indicated.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

F. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Instructor: Manufacturer's authorized representative.
   3. Location: At project site.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

C. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 24 Hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.

3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION 230934

SECTION 233100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

C. Nonmetal ducts.

D. Ducts for laboratory and industrial-grade applications.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 099113 - Exterior Painting: Weld priming, weather resistant, paint or coating.

C. Section 099123 - Interior Painting: Weld priming, paint or coating.

D. Section 230130.51 - HVAC Air-Distribution System Cleaning: Post install duct cleaning.

E. Section 230713 - Duct Insulation: External insulation and duct liner.

F. Section 233300 - Air Duct Accessories.

G. Section 233319 - Duct Silencers.

H. Section 233600 - Air Terminal Units.

I. Section 233700 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

A. ANSI Z9.5 - Laboratory Ventilation; 2022.

B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASHRAE Std 90.1 I-P-2019 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019, with Errata and Addenda (2021).

E. ASHRAE Std 126 - Method of Testing HVAC Air Ducts; 2020.

F. ASME AG-1 - Code on Nuclear Air and Gas Treatment; 2023.

G. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

H. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2025.

I. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.

J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

K. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

M. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2026.

N. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

O. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).

Q. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).

R. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).

S. ISO 6944-1 - Fire Containment -- Elements of Building Construction -- Part 1: Ventilation Ducts; 2024.

T. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals; 2019.

U. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

V. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

W. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2026.

X. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

Y. SMACNA (FGD) - Fibrous Glass Duct Construction Standards; 2021.

Z. SMACNA (FRP) - Thermoset FRP Duct Construction Manual; 2016.

AA. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.

BB. SMACNA (Phenolic) - Phenolic Duct Construction Standards; 2015.

CC. SMACNA (PVC) - Thermoplastic Duct (PVC) Construction Manual; 1995.

DD. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards; 2024.

EE. SMACNA (ROUND) - Round Industrial Duct Construction Standards; 2013.

FF. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

GG. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

HH. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.

D. Samples: Submit two samples of typical shop fabricated duct fittings.

E. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meets or exceed specified requirements.

F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).

G. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

H. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Provide metal duct unless otherwise indicated. Fibrous glass duct can be substituted at the Contractor's option.

C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 233319.

D. Duct Shape and Material in accordance with Allowed Static Pressure Range:
   1. Round: Plus or minus 2 in-wc (500 Pa) of galvanized steel.
   2. Rectangular: Plus or minus 1/2 in-wc (125 Pa) of galvanized steel.
   3. Fibrous Glass Duct-board: Plus or minus 1/2 in-wc (125 Pa).

E. Duct Sealing and Leakage in accordance with Static Pressure Class:
   1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
      a. Supply Air: 1 in-wc (250 Pa) pressure class, galvanized steel.
      b. Outside Air Intake: 1/2 in-wc (125 Pa) pressure class, galvanized steel.
      c. Return and Relief Air: 1/2 in-wc (125 Pa) pressure class, galvanized steel.
      d. General Exhaust Air: 1/2 in-wc (125 Pa) pressure class, galvanized steel.
   2. Low Pressure Service: Up to 2 in-wc (500 Pa):
      a. Seal: Class C, apply to seal off transverse joints.
      b. Leakage:
         1) Rectangular: Class 24 or 24 cfm/100 sq ft (680 Lpm/9.3 sq m).
         2) Round: Class 12 or 12 cfm/100 sq ft (340 Lpm/9.3 sq m).
   3. Low Pressure Service: From 2 in-wc (500 Pa) to 3 in-wc (750 Pa):
      a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
      b. Leakage:
         1) Rectangular: Class 12 or 12 cfm/100 sq ft (340 Lpm/9.3 sq m).
         2) Round: Class 6 or 6 cfm/100 sq ft (170 Lpm/9.3 sq m).
   4. Medium and High Pressure Service: Above 3 in-wc (750 Pa):
      a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.

b. Leakage:
1) Rectangular: Class 6 or 6 cfm/100 sq ft (170 Lpm/9.3 sq m).

F. Duct Fabrication Requirements:
1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

A. Material Requirements:
1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
2. Stainless Steel: ASTM A666, Type 304.

B. Metal Duct Coating Requirements:
1. PVC Coating for Steel Duct: 4 mils (0.1 mm) polyvinyl chloride plastic on both sides.

C. Rectangular Metal Duct:
1. Rectangular Single Wall: Rectangular, longitudinal lock seam duct with galvanized steel wall.

D. Round Metal Ducts:
1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
a. Manufacturers:
1) EHG, a DMI Company; _____: www.ehgduct.com/#sle.
2) Elgen Manufacturing Company, Inc; Snap Lock Pipes and Fittings: www.elgenmfg.com/#sle.
3) Linx Industries, Inc, a DMI Company; _____: www.li-hvac.com/#sle.
4) MKT Metal Manufacturing; _____: www.mktduct.com/#sle.
5) Nordfab Ducting; _____: www.nordfab.com/#sle.
6) Substitutions: See Section 016000 - Product Requirements.
2. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
a. Manufacturers:
1) Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
2) Nordfab Ducting; _____: www.nordfab.com/#sle.
3) Substitutions: See Section 016000 - Product Requirements.

E. Round Spiral Duct:
1. Round spiral lock seam duct with galvanized steel outer wall.

2. Manufacturers:
   a. EHG, a DMI Company; _____: www.ehgduct.com/#sle.
   b. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
   c. GSI, a DMI Company; _____: www.greenseamind.com/#sle.
   d. Linx Industries, Inc, a DMI Company; _____: www.li-hvac.com/#sle.
   e. MKT Metal Manufacturing; _____: www.mktduct.com/#sle.
   f. Substitutions: See Section 016000 - Product Requirements.

F. Connectors, Fittings, Sealants, and Miscellaneous:
1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
   a. Manufacturers:
      1) Carlisle HVAC Products; Nexus Flange Connectors with Sealant Pocket: www.carlislehvac.com/#sle.
      2) Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
      3) Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
      4) MKT Metal Manufacturing; _____: www.mktduct.com/#sle.
      5) Substitutions: See Section 016000 - Product Requirements.
3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   b. VOC Content: Not more than 250 g/L, excluding water.
   c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
   d. For Use with Flexible Ducts: UL labeled.
   e. Manufacturers:
      1) Carlisle HVAC Products; Hardcast Versa-Grip 181 Water Based Fiber Reinforced Duct Sealant: www.carlislehvac.com/#sle.
      2) Design Polymerics; DP 1010 Water Based Smooth Duct Sealant, Premium Quality: www.designpoly.com/#sle.
      3) Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
      4) Elgen Manufacturing Company, Inc; Duct Sealer: www.elgenmfg.com/#sle.
      5) H.B. Fuller Construction Products, Inc; _____: www.fosterproducts.com//#sle.
      6) Substitutions: See Section 016000 - Product Requirements.
4. Gasket Tape:
   a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
   b. Manufacturers:
      1) Design Polymerics; DP 1040 100 Percent Solids, High Pressure/High-Velocity Butyl Gasket Tape: www.designpoly.com/#sle.
      2) Elgen Manufacturing Company, Inc; 440 Butyl Gasket Tape: www.elgenmfg.com/#sle.
      3) Substitutions: See Section 016000 - Product Requirements.
5. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
6. Hanger Fasteners: Attach hangers to structure using appropriate fasteners as follows:

a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.03 FLEXIBLE DUCTS

A. Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form spiral helix.
1. Insulation: R6 insulation with polyethylene vapor barrier film.
2. Pressure Rating: 10 in-wc (2.50 kPa) positive and 5 in-wc (1.25 kPa) negative.
3. Maximum Velocity: 5500 fpm (27.9 m/sec).
4. Temperature Range: Minus 20 degrees F to 250 degrees F (Minus 28 degrees C to 121 degrees C).
5. Manufacturers:
a. Flexmaster USA, a brand of Masterduct, Inc; Type 1: www.flexmasterusa.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Flexible Air Ducts:
1. UL 181, Class 1, polyethylene film supported by helically wound spring steel wire.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
3. Pressure Rating: From 10 in-wc (2.50 kPa) to 5 in-wc (1.25 kPa) negative.
4. Maximum Velocity: 5,500 fpm (27.9 m/s).
5. Temperature Range: Minus 20 to 250 degrees F (Minus 28 to 121 degrees C).
6. Manufacturers:
a. Flexmaster USA, a brand of Masterduct, Inc; Type 1: www.flexmasterusa.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2.04 NON-METAL DUCTS

A. Thermoset Fiber Glass Reinforced Plastic (FRP) Ducts:
1. Glass fiber reinforced plastic with minimum wall thickness of 3/16 inch (5 mm).
2. Manufacturers:
a. Substitutions: See Section 016000 - Product Requirements.

2.05 DUCTS FOR LABORATORY AND INDUSTRIAL-GRADE APPLICATIONS

A. Duct Class:
1. Class 1: Gases at a minimum conveying velocity of 1,000 to 2,000 fpm (5 to 10 m/s).
2. Class 5: Corrosive fumes in light concentrations at a minimum conveying velocity of 1,000 to 2,000 fpm (5 to 10 m/s).

B. Sectional Shape and Material Requirements:
1. Round Metal Duct:
a. Manufacturers:
1) Nordfab Ducting; _____: www.nordfab.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.
b. Pressure Class: Plus or minus 2 in-wc (500 Pa).
c. Pressure Capacity Range:
1) Round: Minus 30 to 50 in-wc (Minus 7.5 to 12.5 kPa).
2) Rectangular: Minus 150 to 150 in-wc (Minus 37.4 to 37.4 kPa).
d. Maximum Air Service Temperature:
1) 250 degrees F (121 degrees C): Aluminum, duct class 1.
e. Minimum Duct Thickness: Duct Class 1, 2 and 5; 18 gauge, 0.048 inch (1.2 mm).
f. Compliance: Provide ductwork, fittings, supports, hangers, and appurtenances:
1) Round: SMACNA (ROUND) construction standard.

2. Round Thermoplastic (PVC I) Duct:
    a. Manufacturers:
        1) Substitutions: See Section 016000 - Product Requirements.
    b. Class 1 Air Duct Capacity:
        1) Pressure Class: Minus 2 in-wc (500 Pa).
        2) Maximum Temperature: 100 degrees F (37.8 degrees C).
    c. Protection: Apply ultraviolet protection for segments exposed to direct sunlight.
    d. Compliance: Provide reinforced ductwork, fittings, supports, hangers, and appurtenances in compliance with SMACNA (PVC).
3. Round Thermoset (FRP) Duct:
    a. Class 5 Air Duct Capacity:
        1) Pressure Class: Minus 10 in-wc (2.5 kPa).
        2) Maximum Temperature: 180 degrees F (82 degrees C).
    b. Protection: Apply weather resistant and ultraviolet protection coatings for segments exposed to direct sunlight.
    c. Compliance: Provide ductwork, fittings, supports, hangers, and appurtenances in accordance with SMACNA (FRP).

C. Laboratory Exhaust Applications:
1. Bio-Safety Cabinet Exhaust:
    a. Class 1, round galvanized steel ductwork.
    b. Coordinate duct, fittings, hangers, and appurtenances to cabinet unit.
    c. Antimicrobial Treatment: Provide EPA-registered antimicrobial coating or touch-up paint tested in accordance with ASTM E84.
2. Fume Hood Cabinet Exhaust:
    a. Minimum 20-gauge, 0.035-inch (0.95 mm) Type 316 stainless steel, unless noted otherwise.
        1) Fabricate in accordance with ductwork manufacturer's instructions; test duct system to sustain positive and negative pressures in accordance with ASHRAE Std 126 and ASME AG-1.
        2) Single-wall, factory built, general use vent system.
            (a) Seal joints during installation with factory-supplied overlapping V-bands and sealant.
    b. Chemicals: Round, class 1 asphalt-coated steel.
    c. Hydrofluoric Acid: Class 5, round thermoplastic (PVDF).
    d. Perchloric Acid: Vertically-installed, round, class 5, thermoplastic (CPVC) ductwork. Provide equidistantly-aligned bulkheads to hold field-terminated internal water spray nozzles.
    e. Provide ductwork and appurtenances in accordance with NFPA 91 requirements except where NFPA 45 applications take precedence.
    f. Coordinate duct, fittings, hangers, and accessories to comply with ANSI Z9.5.
    g. Design, fabricate, and install liquidtight preventing exhaust leakage into the building.
    h. Operating Range: 10 in-wc (2.50 kPa).
    i. Seal joints during installation with factory-supplied flanges amd airtight gasketing.
    j. Provide with factory installed and pressure tested access doors.
    k. Manufacturers:
        1) DuraSystems Barriers Inc; DuraDuct LXD: www.durasystems.com/#sle.
        2) Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products following the manufacturer's instructions.

C. Comply with safety standards NFPA 90A and NFPA 90B.

D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fibrous Glass Ducts: Install in accordance with SMACNA (FGD). Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.

G. Flexible Ducts: Connect to metal ducts with adhesive.

H. PVC Coated Metal Ductwork: Tape with PVC tape.

I. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

J. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.

K. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

L. Use double nuts and lock washers on threaded rod supports.

M. Connect terminal units to supply ducts directly or with one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.

N. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.

O. Set plenum doors at 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

P. Fire Partitions: Provide firestopping sealing. See Section 078400.

Q. Duct Accessories, Terminal Units, Inlets, and Outlets: Interconnect as indicated in Sections 233300, 233600, and 233700.

R. Duct Insulation: Provide duct insulation. See Section 230713.

S. Painting: Provide surface finish as indicated on drawings. See Sections 099113 and 099123.

3.02 CLEANING

A. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

B. Clean thoroughly each duct system. See Section 230130.51.

C. Clean duct systems with high-power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters or bypass during cleaning. Provide adequate access to the ductwork for cleaning purposes.

END OF SECTION 233100

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air turning devices/extractors.
B. Backdraft dampers - metal.
C. Backdraft dampers - fabric.
D. Combination fire and smoke dampers.
E. Duct access doors.
F. Duct test holes.
G. Fire dampers.
H. Flexible duct connectors.
I. Smoke dampers.
J. Volume control dampers.
K. Low leakage (Class 1A) control dampers.
L. Miscellaneous Products:
    1. Damper operators.
    2. Damper position switch.
    3. Fire-rated enclosures.
    4. Internal strut end plugs.
    5. Airflow meters, fixed-resistance type.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.
B. Section 230548 - Vibration and Seismic Controls for HVAC.
C. Section 233100 - HVAC Ducts and Casings.
D. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.
E. Section 253513 - Integrated Automation Actuators and Operators: Damper operators.
F. Section 253516 - Integrated Automation Sensors and Transmitters: Damper position switch.
G. Section 253523 - Integrated Automation Control Dampers: Product furnishing.
H. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.
C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.
D. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2020, with Corrigendum (2022).
E. Modbus (PS) - The Modbus Organization Communications Protocol.; Latest Update.
F. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

G. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

I. NFPA 92 - Standard for Smoke Control Systems; 2021, with Amendment.

J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

K. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.

L. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

M. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

N. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

O. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

P. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

Q. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

R. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Fusible Links: One of each type and size.

1.05 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:
   1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com/#sle.
   2. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
   3. Krueger-HVAC, Division of Air System Components; _____: www.krueger-hvac.com/#sle.

4. Ruskin Company; _____: www.ruskin.com/#sle.
5. Titus HVAC, a brand of Johnson Controls; _____: www.titus-hvac.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.02 BACKDRAFT DAMPERS - METAL

A. Manufacturers:
1. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
2. Nailor Industries, Inc; _____: www.nailor.com/#sle.
3. Pottorff; _____: www.pottorff.com/#sle.
4. Ruskin Company; _____: www.ruskin.com/#sle.
5. United Enertech; _____: www.unitedenertech.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

B. Gravity Backdraft Dampers, Size 18 by 18 inches (450 by 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 BACKDRAFT DAMPERS - FABRIC

A. Fabric Backdraft Dampers: Factory-fabricated.
1. Blades: Neoprene coated fabric material.
2. Birdscreen: 1/2 inch (12 mm) nominal mesh of galvanized steel or aluminum.
3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.04 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. AireTechnologies, Inc, a DMI Company; _____: www.airetechnologies.com/#sle.
2. Lloyd Industries, Inc; _____: www.firedamper.com/#sle.
3. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
4. Nailor Industries, Inc; _____: www.nailor.com/#sle.
5. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
6. Pottorff; _____: www.pottorff.com/#sle.
7. Ruskin Company; _____: www.ruskin.com/#sle.
8. United Enertech; _____: www.unitedenertech.com/#sle.
9. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Provide factory sleeve and collar for each damper.

D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch (1.52 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.

E. Operators: UL listed and labeled; spring-return, pneumatic-type suitable for operation on 0-20 psig (0-140 kPa) instrument air. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.

F. Operators: UL listed and labeled; spring-return, electric-type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.

G. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.05 DUCT ACCESS DOORS

A. Manufacturers:
1. Acudor Products Inc, a Division of Nelson Industrial Inc; _____: www.acudor.com/#sle.
2. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
3. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
4. Lloyd Industries, Inc; _____: www.firedamper.com/#sle.
5. Nailor Industries, Inc; _____: www.nailor.com/#sle.
6. Ruskin Company; _____: www.ruskin.com/#sle.
7. SEMCO LLC; _____: www.semcohvac.com/#sle.
8. The Williams Brothers Corporation of America; _____: www.wbdoors.com/#sle.
9. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch (25 mm) thick insulation with sheet metal cover.
1. Less Than 12 inches (300 mm) Square: Secure with sash locks.
2. Up to 18 inches (450 mm) Square: Provide two hinges and two sash locks.
3. Up to 24 by 48 inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.

2.06 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
1. Manufacturers:
a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal: www.carlislehvac.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2.07 FIRE DAMPERS

A. Manufacturers:
1. AireTechnologies, Inc, a DMI Company; _____: www.airetechnologies.com/#sle.
2. Lloyd Industries, Inc; _____: www.firedamper.com/#sle.
3. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
4. Nailor Industries, Inc; _____: www.nailor.com/#sle.
5. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
6. Panasonic Corporation of North America; Flex Damper: www.panasonic.com/#sle.
7. Pottorff; _____: www.pottorff.com/#sle.

8. Ruskin Company; _____: www.ruskin.com/#sle.
9. United Enertech; _____: www.unitedenertech.com/#sle.
10. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch (0.76 mm) frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch (250 Pa) pressure-class ducts up to 12 inches (300 mm) in height.

E. Multiple Blade Dampers: 16-gauge, 0.0598-inch (1.52 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch (3.2 by 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.

2.08 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
2. Ductmate Industries, Inc, a DMI Company; _____: www.ductmate.com/#sle.
3. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd (1.0 kg/sq m).
a. Net Fabric Width: Approximately 2 inches (50 mm) wide.
2. Metal: 3 inches (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel.

2.09 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.

C. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.10 VOLUME CONTROL DAMPERS

A. Products for Automatic Controls: See Section 253523.

B. Manufacturers:
1. AireTechnologies, Inc, a DMI Company; _____: www.airetechnologies.com/#sle.
2. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
3. Elgen Manufacturing Company, Inc; _____: www.elgenmfg.com/#sle.
4. MKT Metal Manufacturing; _____: www.mktduct.com/#sle.
5. Nailor Industries, Inc; _____: www.nailor.com/#sle.
6. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
7. Pottorff; _____: www.pottorff.com/#sle.

8. Ruskin Company; _____: www.ruskin.com/#sle.
9. Substitutions: See Section 016000 - Product Requirements.

C. Fabricate in accordance with SMACNA (DCS) and as indicated.

D. Splitter Dampers:

E. Single Blade Dampers:
1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.

F. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches (200 by 1825 mm). Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.

G. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
1. Manufacturers:
a. Carlisle HVAC Products; Dynair End Bearing Leak Resistant Sets: www.carlislehvac.com/#sle.
b. Elgen Manufacturing Company, Inc; Snap-In Bushing: www.elgenmfg.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

H. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.
4. Manufacturers:
a. Carlisle HVAC Products; Dynair Double Shear Rattle Free Quadrants 1/2 inch: www.carlislehvac.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2.11 MISCELLANEOUS PRODUCTS

A. Damper Operators: Provide electric operators; see Section 253513.

B. Damper position switch; see Section 253516.

C. Fire-Rated Enclosures:
1. Manufacturers:
a. Fire Rated Product Specialties Corp; _____: www.frpsonline.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.
2. Provide as required to preserve fire resistance rating of building elements.

D. Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.
1. Manufacturers:
a. Substitutions: See Section 016000 - Product Requirements.

E. Airflow Meters, Fixed-Resistance Type:
1. Manufacturers:
a. KMC Controls; Conquest Airflow Measurement System: www.kmccontrols.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2. Sensor Type: Provide duct-inserted probe, duct-inserted pitot-tube assembly, and wall-mounted assembly for outside air with built-in transmitter.
3. Flow Range: Equivalent velocity pressure required to match scheduled flow range with 100-to-1 signal turndown ratio.
4. Accuracy: Two percent over a 30 to 50 millisecond response time, adjustable.
5. Linearity: 0.1 percent of calibrated span.
6. Minimum Overpressure: 150 percent over highest range value.
7. Output: Two-wire, 4 to 20 mA.
8. Access Box: NEMA EN 10250, Type 1 with hinged cover housing and cable access ports.
9. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
10. Accessories: Include barbed fittings, 3-way valve per pressure port, and pressure snubber per port unless factory fitted into transmitter.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 233100 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch (200 by 200 mm) size access door for hand and shoulder access, or as indicated on drawings. Provide minimum 4 by 4 inch (100 by 100 mm) size access door for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
   1. See Section 230548.

J. For fans developing static pressures of 5.0 inches (1250 Pa) and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.

K. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

L. Use splitter dampers only where indicated.

M. Provide balancing dampers on high velocity systems where indicated. See Section 233600.

N. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 233300

SECTION 233416
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backward inclined centrifugal fans.

B. Forward curved centrifugal fans.

C. Bearings and drives.

D. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment.

B. Section 230548 - Vibration and Seismic Controls for HVAC.

C. Section 230713 - Duct Insulation.

D. Section 233300 - Air Duct Accessories: Backdraft dampers.

E. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 2014 (Reaffirmed 2020).

C. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.

D. AMCA 99 - Standards Handbook; 2025.

E. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

F. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

H. NEMA MG 00001 - Motors and Generators; 2024.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Include complete installation instructions.

E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Fan Belts: One set for each individual fan.

1.05 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.07 FIELD CONDITIONS

A. Permanent fans may not be used for ventilation during construction.

B. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ACME Engineering and Manufacturing Corporation; _____: www.acmefan.com/#sle.

B. Carnes, a division of Carnes Company Inc; VIBK: www.carnes.com/#sle.

C. Loren Cook Company; _____: www.lorencook.com/#sle.

D. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

E. Substitutions: See Section 016000 - Product Requirements.

2.02 MANUFACTURERS BY FAN TYPE

A. Backward-Inclined Centrifugal Fans:
   1. ACME Engineering and Manufacturing Corporation; _____: www.acmefan.com/#sle.
   2. Loren Cook Company; _____: www.lorencook.com/#sle.
   3. PennBarry, Division of Air Systems Components; _____: www.pennbarry.com/#sle.
   4. Twin City Fan & Blower; TCBI: www.tcf.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. Plug Fans:
   1. ACME Engineering and Manufacturing Corporation; _____: www.acmefan.com/#sle.
   2. Loren Cook Company; _____: www.lorencook.com/#sle.
   3. PennBarry, Division of Air Systems Components; _____: www.pennbarry.com/#sle.
   4. Rosenberg USA, Inc; AC Fans with External Rotor Motor: www.rosenbergusa.com/#sle.
   5. Twin City Fan & Blower; _____: www.tcf.com/#sle.
   6. Substitutions: See Section 016000 - Product Requirements.

2.03 PERFORMANCE REQUIREMENTS

A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Comply with AMCA 99.

D. Performance Base: Sea level conditions.

E. Temperature Limit: Maximum 300 degrees F (150 degrees C).

F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

2.04 WHEEL AND INLET

A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

B. Forward Curved: Black enameled steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to backplate and keyed to shaft with set screw.

2.05 HOUSING

A. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

B. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, provide two additional coats of paint. Prime coating on aluminum parts is not required.

C. Provide bolted construction with horizontal flanged split housing, where indicated.

D. Fabricate plug fans without volute housing using steel-lined cabinet; see Section 230713.

2.06 BEARINGS AND DRIVES

A. Bearings: Heavy duty pillow block type, selfgreasing ball bearings, with ABMA STD 9 life at 50,000 hours or ball bearings, with ABMA STD 9 life at 100,000 hours.

B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.

C. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 Kw) and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp (15 Kw) and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

D. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.07 ACCESSORIES

A. Discharge Dampers: Parallel blade heavy-duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.

B. Access Doors: Shaped to fit scroll, with quick opening latches and gaskets.

C. Scroll Drain: 1/2 inch (13 mm) steel pipe coupling welded to low point of fan scroll.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install fans with resilient mountings and flexible electrical leads, see Sections 230548 and 260583.

C. Install flexible connections between fan inlet and discharge ductwork; see Section 233300. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.

D. Install fan restraining snubbers; see Section 230548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

E. Provide fixed sheaves required for final air balance.

F. Provide safety screen where inlet or outlet is exposed.

G. Pipe scroll drains to nearest floor drain.

END OF SECTION 233416

SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

B. Upblast roof exhausters.

C. Inline centrifugal fans and blowers.

D. Utility vent blowers.

E. Laboratory-fume exhaust fans.

1.02 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping.

B. Section 221006 - Plumbing Piping Specialties.

C. Section 230513 - Common Motor Requirements for HVAC Equipment.

D. Section 230548 - Vibration and Seismic Controls for HVAC.

E. Section 233100 - HVAC Ducts and Casings.

F. Section 233300 - Air Duct Accessories: Backdraft dampers.

G. Section 251400 - Integrated Automation Local Control Units.

H. Section 234000 - HVAC Air Cleaning Devices.

I. Section 251400 - Integrated Automation Local Control Units.

J. Section 253516 - Integrated Automation Sensors and Transmitters.

K. Section 253523 - Integrated Automation Control Dampers.

L. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

M. Section 262923 - Variable-Frequency Motor Controllers.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.

B. AMCA 99 - Standards Handbook; 2025.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

E. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance; 2022, with Editorial Revision (2023).

F. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating; 2020.

G. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

I. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.

J. ANSI Z9.5 - Laboratory Ventilation; 2022.

K. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

L. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals; 2019.

M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

N. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2026.

O. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

P. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate fan roof curbs and service utilities installation according to fan size.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are completed in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Fan Belts: One set for each individual fan.

1.06 QUALITY ASSURANCE

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

1.07 FIELD CONDITIONS

A. Request Owner permission to use permanent ventilator(s) for ventilation during construction.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

2.02 MANUFACTURERS

A. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.

B. Loren Cook Company; _____: www.lorencook.com/#sle.

C. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

D. Twin City Fan & Blower; _____: www.tcf.com/#sle.

E. Substitutions: See Section 016000 - Product Requirements.

2.03 POWER VENTILATORS - GENERAL

A. Manufacturers:
   1. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.
   2. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

3. Substitutions: See Section 016000 - Product Requirements.

B. Static and Dynamically Balanced: Comply with AMCA 204.

C. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

D. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

E. Fabrication: Comply with AMCA 99.

F. UL Compliance: UL 705, listed, labeled, designed, manufactured, and tested.

G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

H. Enclosed Safety Switches: Comply with NEMA EN 10250.

2.04 ROOF EXHAUSTERS

A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch (13 mm) mesh, 0.62 inch (1.6 mm) thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.05 UPBLAST ROOF EXHAUSTERS

A. Manufacturers:
   1. Greenheck Fan Corporation: www.greenheck.com/#sle.
   2. Patterson Fan Company, Inc: www.pattersonfan.com/#sle.
   3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Belt Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum, statically and dynamically balanced.
   2. Housing:
      a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.

b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
c. 100 percent factory tested.

D. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

E. Disconnect Switches:
1. Factory mounted and wired.
2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
a. Outdoor Locations: Type 3R.
3. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
4. Positive electrical shutoff.
5. Wired from fan motor to junction box installed within motor compartment.

F. Roof Curb: 16 inch (400 mm) high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

G. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

H. Options/Accessories:
1. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
2. Dampers: Provide gravity type.
3. Drain Connection:
a. Allows single-point drainage of grease, water, or other residues.
4. Finishes: Factory primed.
5. Tie-down Points: Four brackets located on windband secures fan in heavy wind applications.

I. Performance Ratings: As indicated on drawings.
1. Motor:
a. Wiring: See Section 260583.
b. Motor Type: NEMA MG 1.
c. Heavy duty ball bearing type.
d. Fully accessible for maintenance.
e. Mount on vibration isolators or resilient cradle mounts, out of air stream.

2.06 INLINE CENTRIFUGAL FANS AND BLOWERS

A. Manufacturers:
1. Greenheck Fan Corporation: www.greenheck.com/#sle.
2. Loren Cook Company: www.lorencook.com/#sle.
3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
4. Twin City Fan & Blower; BSI: www.tcf.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.

C. Backward Inclined Blower:
   1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, powder-coated steel housing for outdoor service, and removable service panels.
   2. Service Temperature: Minus 65 to 250 degrees F (Minus 54 to 121 degrees C).
   3. Operation: As indicated on drawings.
   4. Accessories: Provide external vibration isolator spring and filter section.

D. Disconnect Switch: Cord and plug-in housing for thermal overload protected motor.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

2.07 UTILITY VENT BLOWERS

A. Direct Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum, statically and dynamically balanced.
   2. Housing:
      a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

C. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. Motor pulley adjustable for final system balancing.
   5. Readily accessible for maintenance.

D. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

2.08 LABORATORY FUME-EXHAUST FANS

A. Manufacturers:
   1. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.
   2. Loren Cook Company; _____: www.lorencook.com/#sle.
   3. Strobic Air Corporation; _____: www.strobicair.com/#sle.
   4. Twin City Fan & Blower; TVIFE: www.tcf.com/#sle.
   5. Substitutions: See Section 016000 - Product Requirements.

B. General Requirements:
   1. Fan Type: Roof-curb mounted, constant stack-velocity discharge laboratory exhaust.
   2. Minimum air discharge velocity of 3,000 fpm (15.2 m/s) in compliance with ANSI Z9.5.
   3. Provide fan-assembly manufactured to sustain structural integrity without external guy-wires or supplemental supports at wind speeds up to 125 mph (201 kmh).
   4. Fan performance tested in accordance with AMCA 210, AMCA 260, and AMCA 300.
   5. Fan performance ratings certified in accordance with AMCA 211 and AMCA 311.
   6. Explosion Resistant Construction: Provide fan classified as Spark B with motor and drive-assembly outside of contaminated airstream in compliance with AMCA 99.
   7. Comply with NFPA 90A and NFPA 91 requirements for chemical laboratory applications per NFPA 45.

C. Application:
   1. Dedicated Fume Hood Exhaust:
      a. Fan Type: Belt-driven, single-speed motor with epoxy-based protective coating.
      b. Exhaust Capacity: Select fan to handle full exhaust airflow rate, system static pressure loss with 15 percent load-capacity factor, and minimum discharge plume height of 10 feet (3 m) above roof level.
   2. Hazardous-Material Fume Hood Exhaust:
      a. Per acid digestion, perchloric acid, hydrochloric acid, and radiation fume hood.
      b. Fan Type: Direct-driven, single-speed motor with electrostatic powder-protective coating.
      c. Exhaust Capacity: Select fan to handle full exhaust airflow rate, system static pressure loss with 20 percent load-capacity factor, and minimum discharge plume height of 45 feet (13.7 m) above roof level.
      d. Exhaust Ductwork: Use non-reactive material; see Section 233100.
      e. Perchloric Acid Fume Hood Exhaust Provisions:
         1) Install and plumb ductwork using vertical and sloped runs only.
         2) Provide duct-mounted water wash down and drain system to flush fully, fan outlet, fan, duct-run, hood-collar exhaust connection, and internal hood surfaces; see Sections 221005 and 221006. Control system manually from fume-hood-mounted hand valve.
   3. Multiple Exhaust Loads including Fume Hoods and Lab Equipment:
      a. Fan Type: Direct-driven, inverter-duty motor fan with VFD finished with electrostatic powder protective coating; see Section 262923. Include fan-fitted air-mixing plenum box with side-mounted bypass damper sized to handle 25 percent over minimum flow.
      b. Exhaust Capacity: Select dual fan set for weekly lead-lag operation to handle combined peak hood-exhaust airflow rates, system static pressure loss with 20 percent load-capacity factor, and minimum discharge plume height of 30 feet (9.1 m) above roof level.
   4. Single or Multiple BSC Class II Type B Exhaust:
      a. Provide HEPA filter containment housing in compliance; see Section 234000.
      b. Fan Type: Direct-driven, inverter-duty motor fan with VFD finished with electrostatic powder protective coating; see Section 262923. Include fan-fitted air-mixing plenum box with side-mounted bypass damper sized to handle 25 percent over minimum flow.
      c. Exhaust Capacity: Select fan set for weekly lead-lag operation to handle combined peak hood-exhaust airflow rates, system static pressure loss with 20 percent load-capacity factor, and minimum discharge plume height of 45 feet (13.7 m) above roof level.

D. Fan Section Requirements:
   1. Impeller:
      a. Non-overloading, backward-inclined centrifugal.
      b. Material: Non-ferrous (Spark classified).
   2. Fan Shaft:
      a. Ground and polished steel with anticorrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
      c. Enclosed over OSHA recommended safety-yellow painted guards.
   3. Bearings:
      a. 100 percent factory tested surface-mounted bearings outside of the airstream.
      b. Operate during a minimum L10 service life in excess of 100,000 hours at maximum cataloged operating speed.
   4. Belt-drive Assembly:
      a. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
      b. Belts: Static-free and oil resistant.
      c. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
      d. Motor pulley adjustable for final system balancing, readily accessible for maintenance.
   5. Housing:
      a. Construct of heavy gauge coated steel with standard factory finish.
      b. Mounting Base:
         1) External mounting base with lifting lugs.
         2) One-piece fabricated or fully welded integral reinforced curb-cap base.
      c. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
      d. Provide breather tube for fresh air motor cooling and wiring.
      e. Bolted Access Doors or Panels: Provide to access impeller, roof curb, and serviceable items within.
      f. Drain Connection: Single-point drainage at lowest point, match assembly finish.
      g. Heat Baffle: Prevents heat from radiating into motor compartment.
      h. Minimum Assembly Height: 120 inches (3048 mm) above the roof surface.
   6. Isolation Damper:
      a. With parallel blade damper, constructed of matching materials and finish.
      b. Provided by manufacturer, bolted to access drawer or panel for easy removal from contaminated airstream.
      c. With two-position damper actuator:
         1) Provided by manufacturer.
         2) Operate interlocked with fan starter.
         3) With integral auxiliary switches to monitor blade position status.
         4) Rated for NEMA EN 10250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected through linkages.
   7. Fan Discharge Outlet-Nozzle:
      a. High Plume with Dilution: Conical shaped nozzle with integral wind band manufactured to facilitate a attaining required air-discharge velocity of diluted exhaust airflow by mixing it with surrounding ambient air.
         1) Wind band to include built-in sound attenuation while maintaining minimum assembly height.
         2) Wind band to include built-in tie-down points in the form of four brackets located to secure fan in heavy wind applications.

8. Fan Inlet Flow Sensor: Provide factory-mounted pitot tube-based differential pressure sensor probe ready for connection into differential pressure-based flow transmitter.
    a. Manufacturer-provided differential pressure transmitter to transducer differential pressure readings into 4 - 20 mA DC scaled flow signal. Include two independently adjustable SPDT dry-contact outputs.
    b. Provide differential pressure transmitter; see Section 253516.
    c. Transmitter Housing: Provide NEMA EN 10250, Type 4 enclosure.

E. Disconnect Switch:
1. Factory-mounted in NEMA EN 10250, Type 3R box wired in compliance with Section 260583.
2. Switchbox Finish: Manufacturer's standard unless otherwise indicated.

F. Air-Mixing Plenum Box:
1. Continuously welded insulated box using assembly matching material and finish on both interior and exterior sides.
2. Provide factory-mounted box on heavy-duty roof curb with integral box-lifting lugs and skirt.
3. Insulation: Water-resistant sound-absorbing material.
4. Include bolted and gasketed access panels for servicing and maintenance.
5. Locate exhaust intake opening on the bottom end fitted with matching duct connecting fitting and safety screen.
6. Locate fan inlet opening on the upper end fitted with matching assembly-base and flow straightener.
7. Air-bypass Intake:
    a. With opposed blade damper, constructed of matching materials and finish.
    b. Provided by manufacturer, bolted for easy removal from contaminated airstream.
    c. With proportional damper actuator:
        1) Provided by manufacturer.
        2) Controlled by manufacturer-provided controller (OEM).
        3) Integral potentiometer to monitor blade position.
        4) Rated for NEMA EN 10250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected throughlinkages.
    d. Covered by damper enclosing weatherhood with intake birdscreen.

G. Roof Curbs:
1. 12 inch (300 mm) high flanged, self-flashing of matching material and finish with continuously welded seams.
2. Provide integral formed steel support framework with curb cap guides.

H. Performance Ratings: As indicated on drawings.
1. Motor:
    a. Wiring: See Section 260583.
    b. Motor Type: NEMA MG 1.
    c. Mount on vibration isolators or resilient cradle mounts, out of air stream.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. Provide sheaves required for final air balance.

E. Install backdraft dampers on inlet to roof and wall exhausters.

F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION 233423

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SECTION 233600
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single-duct terminal units.
   1. Variable-volume units.
B. Venturi-type air valves.
C. Booster coils.
D. Controls for terminal units.

1.02 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment.
B. Section 230548 - Vibration and Seismic Controls for HVAC.
C. Section 230913 - Instrumentation and Control Devices for HVAC: Thermostats and actuators.
D. Section 230923 - Direct-Digital Control System for HVAC.
E. Section 233100 - HVAC Ducts and Casings.
F. Section 233300 - Air Duct Accessories.
G. Section 233700 - Air Outlets and Inlets.
H. Section 251400 - Integrated Automation Local Control Units: HVAC controllers.
I. Section 251500 - Integrated Automation Software: BAS or BMS.
J. Section 253516 - Integrated Automation Sensors and Transmitters: Sensors and switches.
K. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).
C. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets; 2008, with Addendum (2011).
D. ASHRAE RP-1455 - Seminar 65 - Standardized Best of Class Sequences for HVAC Systems; 2016.
E. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2025.
G. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).
H. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.
I. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.
K. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

N. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2024.

O. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

P. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Completion utility connections in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc (250 to 1000 Pa).

D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

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

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME UNITS

A. Manufacturers:
   1. Johnson Controls, Inc; _____: www.johnsoncontrols.com/#sle.
   2. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
   3. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.

4. Price Industries; _____: www.priceindustries.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. General:
1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

C. Unit Casing:
1. Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel.
a. Casing leakage to meet ASHRAE Std 130.
2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
3. Unit Discharge: Rectangular, with slip-and-drive connections.
4. Acceptable Liners:
a. 1/2 inch (13 mm) thick, coated, fibrous-glass complying with ASTM C1071.
1) Secure with adhesive.
2) Coat edges exposed to airstream with NFPA 90A approved sealant.
3) Cover liner with non-porous foil.
b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Sound Attenuator:
1. Provide if required to meet scheduled acoustical performance requirements.
2. Construction to consist of a continuous extension of the casing and liner as required to achieve required attenuation.
3. At 2000 fpm (10.16 m/s) inlet velocity, the minimum operating pressure with attenuator added not to exceed 0.14 in-wc (34.84 Pa).

E. Damper Assembly:
1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.
a. Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 in-wc (750 Pa) inlet static pressure, tested in accordance with ASHRAE Std 130.

F. Electric Heating Coil:
1. Listed and provided by the terminal unit manufacturer.
2. Coil Casing: 20 gauge, 0.0359 inch (0.92 mm) galvanized steel.
3. Heating Elements: Nickel chrome, supported by ceramic insulators.
4. Integral Control Panel: NEMA EN 10250, Type 2 enclosure with hinged access door for access to all controls and safety devices.
5. Furnish a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow.
6. Provide the following additional components, mounted and/or wired within the control enclosure:
a. Fused or non-fused door interlocking disconnect switch.
b. Mercury contactors.
c. Fuse block.

7. Factory wired, including all limit switches and steps of control as indicated on the equipment schedule, with the SSR (solid-state relay) proportional heat control.
8. Provide SCR (Silicon Controlled Rectifier) controller.

G. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

H. Control Transformers: Factory supplied and mounted for electric and electronic control applications.

I. Controls:
1. DDC (Direct-Digital Controls):
a. Include a factory-installed, unit-mounted, direct-digital controller.
b. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
c. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFMs.
1) Occupied and unoccupied operating mode.
2) Remote reset of temperature or CFM set points.
3) Proportional, plus integral control of room temperature.
4) Monitoring and adjusting with portable terminal.
d. Room Sensor:
1) Compatible with temperature controls specified.
2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
e. See Section 25 1400.
2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
a. Signal accuracy: Plus/minus five percent throughout terminal operating range.

2.02 VENTURI-TYPE AIR VALVES

A. Manufacturers:
1. Antec Controls, a brand of Price Industries, Inc; _____: www.anteccontrols.com/sle#.
2. Phoenix Controls, a company of Honeywell International, Inc; _____: www.phoenixcontrols/sle#.
3. Substitutions: See Section 016000 - Product Requirements.

B. Type: Pressure independent, field adjustable, maintenance-free, directional-flow tagged, factory calibrated to operate across body-stamped flow curve.

C. Construction:
1. Body Material: Aluminum, 14 gauge, 0.064 inch (1.63 mm), stainless steel coated.
2. Cone Material: Aluminum, 14 gauge, 0.064 inch (1.63 mm), stainless steel coated.
3. Shaft, Bearings, and Links Material: 316 stainless steel.
4. Valve-Assembly Orientation: As indicated on drawings.
5. Flow-Valve Type:
a. Fume Hood: Variable volume, partially closed.
b. Bio-Safety Cabinet: Two position, partially closed.
c. General Exhaust: Variable volume, partially closed.
d. Supply: Variable volume, partially closed.
6. Actuator Configuration: Electronic, high speed, fail closed.
7. Flow Feedback: Built-in calibrated potentiometer with pressure switch.
8. Size with Coupling Type: 8 inches (20 cm), single with slip end.

9. Sound Attenuator: As indicated on drawings.
10. Thermal Insulation (Supply): Flexible closed-cell polymer-based foam, 3/8 inch (9.5 mm).

D. Operating Range:
1. Flow: As indicated on drawings.
2. Accuracy: Plus or minus 5 percent of scheduled flow setpoints.
3. Control Response Time: Under one second.

E. Auxiliary Heating or Reheating: Provide electric booster coil.

F. Terminal Unit Controls:
1. Controller: Built-into valve, extend power and communication bus to other system valves.
2. Factory ship DDC controller including airflow transmitter and damper actuator.
3. Provide accessories for field interfaced controller including ball valve, duct-mounted temperature sensor, and thermostat.
4. Control Sequence: Dynamic space volume matching to attain area offset setpoint with pressure differential reset.

2.03 BOOSTER COILS

A. Manufacturers:
1. Antec Controls a brand of Price Industries, Inc; _____: www.anteccontrols.com/sle#.
2. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.
3. Indeeco, a company of ASPEQ Heating Group; _____: indeeco.com/sle#.
4. Nortek Coil Solutions: www.nortekair.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Electric Heating Coil:
1. Type: Open-coil made of 80/20 nickel-chrome heating bare-wire elements sheathed in electrically-insulated layer sized to match kW rating.
2. Frame: Slip-in type made of aluminized steel sized to match as minimum 80 percent of horizontal traverse duct area.
3. Terminal Box: NEMA EN 10250, Type 4 enclosure made of frame material with left-side hinged access door sized to house components and accessories.
4. Terminal Unit Controls:
a. Provide DDC controller including duct-mounted temperature sensor and thermostat.
b. Sequence of Operation: Zone air temperature control with coil discharge monitoring.
5. Electrical Requirements:
a. Service Power: 480 VAC, three phase, 60 Hz.
b. Factory assembled and prewired in compliance with NFPA 70 requirements.
c. Safety Device Interface: Provide single-point door-handle disconnect switch, primary fuses, airflow switch, and primary-secondary thermal cut-out switches.

2.04 CONTROLS FOR TERMINAL UNITS

A. Electric, 24 VAC:
1. Zone Thermostat, Heating and Cooling:
a. Electromechanical SPDT switch device, direct or reverse acting, see Section 253516.
b. Show value and setpoint using built-in thermometer in celsius and fahrenheit units.
c. Wall-mounted device with occupancy switch and setpoint adjust.
2. Damper Actuator:
a. DAT (duration-adjust-travel), fail in last position.
b. Controlled By: Wall-mounted thermostat.

B. Electronic, Heating:
1. Programmable device, direct or reverse acting with night setback.

2. Display temperature with setpoint in celsius and fahrenheit units.
3. Wall-mounted device with occupancy switch, setpoint adjust, and service port.

C. Direct or Distributed Digital Controller (DDC), Integrated:
1. Provide application specific controller, see Section 251400 and 251500.
2. Accuracy: Plus/minus five percent of analog input readings and analog outputs.
3. Sequence of Operation: Follow ASHRAE RP-1455 for specific terminal unit.
4. Upstream Flow Sensor: Pitot-tube array, otherwise see Section 253516.
5. Discharge Temperature Sensor: Duct-mounted probe, see Section 253516.
6. Zone Thermostat:
   a. Temperature sensor based device, see Section 253516.
   b. Wall-mounted with occupancy sensor, setpoint adjust, and service port.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

E. Do not support from ductwork.

F. Connect to ductwork in accordance with Section 233100.

G. Verify that electric power is available and of the correct characteristics.

3.03 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide manufacturer's field representative to test, inspect, instruct, and observe field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
1. Leak Test:
   a. After installation, fill water coils and test for leaks.
   b. Repair leaks and retest until no leaks exist.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Test and adjust controls and safeties.
   c. Replace damaged and malfunctioning controls and other equipment.
   d. Remove and replace malfunctioning units and retest as specified above.

3.05 CLEANING

A. Vacuum clean coils and inside of units.

3.06 CLOSEOUT ACTIVITIES

A. See Section 017900 - Demonstration and Training for additional requirements.

END OF SECTION 233600

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SECTION 233700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers:
   1. Critical environment diffusers.
   2. Perforated ceiling diffusers.

B. Rectangular ceiling diffusers.

C. Registers/grilles:
   1. Ceiling-mounted, exhaust and return register/grilles.
   2. Wall-mounted, exhaust and return register/grilles.

D. Duct-mounted supply and return registers/louvers.

E. Fan filter units.

F. Fabric air distribution devices.

1.02 REFERENCE STANDARDS

A. ACGIH (IV) - Industrial Ventilation: A Manual of Recommended Practice for Design, 31st Edition; 2023, with Errata (2025).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

C. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.

D. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2021, with Editorial Revision (2022).

E. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2023.

F. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2025.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026.

H. IEST-RP-CC001 - HEPA and ULPA Filters; 2016, with Errata (2017).

I. ISO 14644-1 - Cleanrooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness by Particle Concentration; 2015.

J. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods; 2020b (Validated 2025).

K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

L. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

M. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

N. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

O. UL 507 - Electric Fans; Current Edition, Including All Revisions.

P. UL 586 - High Efficiency, Particulate, Air Filter Units; Current Edition, Including All Revisions.

Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

R. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

S. UL 2518 - Standard for Safety Air Dispersion Systems; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Samples: Submit two of each required air outlet and inlet type.

D. Project Record Documents: Record actual locations of air outlets and inlets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Louver Company; ALC Grilles and Registers: www.americanlouver.com/#sle.

B. Carnes, a division of Carnes Company Inc; _____: www.carnes.com/#sle.

C. EHG, a DMI Company; _____: www.ehgduct.com/#sle.

D. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.

E. Linx Industries, Inc, a DMI Company; _____: www.li-hvac.com/#sle.

F. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.

G. Price Industries; _____: www.priceindustries.com/#sle.

H. Titus, a brand of Air Distribution Technologies; _____: www.titus-hvac.com/#sle.

I. Tuttle and Bailey; _____: www.tuttleandbailey.com/#sle.

J. Substitutions: See Section 016000 - Product Requirements.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:
   1. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
   2. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.
   3. Price Industries.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.

C. Connections: As indicated on drawings.

D. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.

E. Fabrication: Steel with baked enamel finish.

F. Color: As selected by Architect from manufacturer's standard range.

G. Accessories: Provide radial opposed blade, butterfly, and combination splitter volume control damper; removable core, sectorizing baffle, safety chain, wire guard, equalizing grid, operating rod extension, anti-smudging device, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

2.03 PERFORATED FACE CEILING DIFFUSERS

A. Manufacturers:
   1. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
   2. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.
   3. Price Industries

4. Substitutions: See Section 016000 - Product Requirements.

B. Type: Perforated face with fully adjustable pattern and removable face.

C. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Steel with steel frame and baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

F. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.04 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

A. Manufacturers:
1. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
2. EHG, a DMI Company; _____: www.ehgduct.com/#sle.
3. Linx Industries, Inc, a DMI Company; _____: www.li-hvac.com/#sle.
4. Price Industries
5. Substitutions: See Section 016000 - Product Requirements.

B. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.

C. Material: 22 gauge, 0.0299 inch (0.76 mm).
1. Provide crossing spiral fitting-body of matching duct diameter.

D. Color: As indicated on drawings.

2.05 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
1. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
2. Price Industries
3. Substitutions: See Section 016000 - Product Requirements.

B. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical face.

C. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Fabrication: Stainless steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.06 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
1. Kreuger HVAC.
2. Price Industries
3. Substitutions: See Section 016000 - Product Requirements.

B. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, vertical face.

C. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.

D. Fabrication: Steel frames and blades, with factory baked enamel finish.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.07 CRITICAL ENVIRONMENTS DIFFUSERS

A. Manufacturers:
1. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
2. Metalaire, a brand of Metal Industries Inc; _____: www.metalaire.com/#sle.
3. Price Industries.
4. Substitutions: See Section 016000 - Product Requirements.

B. General Requirements:
1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.

C. Laminar Flow Diffusers:
1. Construction: Stainless steel.
2. Frame: Provide framing per manufacturer's recommendations.
3. Minimum Temperature: 0 degrees F (minus 17 degrees C).
4. Maximum Temperature: 200 degrees F (93 degrees C).
5. Dimensions: As indicated on the drawings.
6. Color: To be selected by Architect from manufacturer's standard range.
7. Damper: Provide volume control in accordance with manufacturer's recommendations.
8. Manufacturers:
   a. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
   b. Price Industries
   c. Substitutions: See Section 016000 - Product Requirements.

D. Radial Flow Diffusers:
1. Construction: Stainless steel.
2. Frame: Provide framing in accordance with manufacturer's recommendations.
3. Minimum Temperature: 0 degrees F (minus 17 degrees C).
4. Maximum Temperature: 200 degrees F (93 degrees C).
5. Dimensions: As indicated on drawings.
6. Color: To be selected by Architect from manufacturer's standard range.
7. Damper: Provide volume control in accordance with manufacturer's recommendations.
8. Manufacturers:
   a. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
   b. Price Industries.
   c. Substitutions: See Section 016000 - Product Requirements.

2.08 FAN FILTER UNITS

A. General Requirements:
1. Comply with ISO 14644-1.
2. Comply with UL 507.
3. Comply with UL 586.

B. Performance Rating:
1. Provide unit factory sealed and tested to ensure leakage consistent with filter.
2. Filter Efficiency: 99.99 percent (HEPA) at 0.30 microns or higher particle size when tested in accordance with DOP-smoke (Dioctyl Phthalate) penetration test on MIL-STD-282.

3. Leakage Scan Tested: Certified as pinhole-free at:
   a. Air velocity capacity of 500 fps (152.4 m/sec).
   b. Resistance from 0.5 in-wc (124.3 Pa) to 2.0 in-wc (497.9 Pa).

C. Media: Pleated, water-resistant glass fiber with aluminum separators.

D. Face Gasket: Silicone.

E. Media to Frame Side Bond: Silicone.

F. Filters:
   1. Filter Type: HEPA in accordance with IEST-RP-CC001.
   2. Filter Replacement Type:
      a. Room side removable and replaceable, mounted in extruded aluminum frame with integral cavity filled with urethane gel to provide leak-tight seal between filter frame and border.
   3. Filter Pack Depth: 2 inches (50.2 mm).

G. Plenum:
   1. Construction: 304 stainless steel.
   2. Provide diffuser plenum with eyebolts at each plenum corner for securing unit to structural supports above ceiling. Each eyebolt to support a maximum of 75 lb (34.02 kg).

H. Inlet: Standard round or optional square collar for nonducted applications.

I. Face and Frame:
   1. Face: 304 stainless steel expanded metal grille with powder-coat paint finish.
   2. Provide distribution plate with 51 percent free area that is secured to face using quarter-turn fasteners with anti-slip, snap-in retainers and stainless steel retainer cables for ease of installation and removal.

J. Fan:
   1. Provide centrifugal type supplied with rubber mounts to isolate motor and blower assembly from diffuser plenum.
   2. Provide direct drive, forward-curved impeller.

K. Fan Motor:
   1. Electrically Commutated Motor (ECM):
      a. Constant Torque Program:
         1) Provide constant torque program to allow ECM to vary airflow with fluctuations in both upstream static pressure and filter pressure drop.
         2) Provide constant torque program to prevent unexpected motor operation or motor shutdown due to upstream static pressure fluctuations.
         3) Provide constant torque program for ducted applications where fluctuations in upstream pressure could occur.
   2. Fan motor shaft directly connected to fan and isolated from casing to prevent transmission of vibration.
   3. Fan motor to have internal thermal and overload protection.
   4. Motor and Blower Access:
   5. Fan Motor with Motor Speed Controller:
      a. ECM Standard Speed Controller:
         1) Provide ECM speed controller with BAS interface to accept 2 VDC to 10 VDC signal for variable speed remote control, and remotely shut off via BAS signal.

L. Accessories:
   1. Prefilter:
      a. Nonducted Units:

1) Provide with MERV 8 pre-filter.
2. Filter replacement alarm system.
3. Aerosol Test System:
   a. Provide room-side accessible aerosol test system for injecting aerosol challenge into diffuser to allow filter to be scanned for leaks during commissioning or after filter replacement.
4. BACnet Daisy-Chain Compatible Units:
   a. Provide RJ45 networking cable for BACnet daisy-chain connection.

2.09 FABRIC AIR DISTRIBUTION DEVICES

A. General Requirements:
   1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
   2. Air Dispersion Method:
   3. Hanger Supports:

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.

F. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

G. For Installation of Fan Filter Units:
   1. Do not begin installation until substrates and openings have been properly prepped.
   2. Verify location of cleanroom fan filter units for installation.
   3. Verify supports, surfaces, and openings are ready for fit out.
   4. Clean and prepare surfaces per manufacturer's instructions.
   5. Install in accordance with manufacturer's written instructions and recommendations and in proper relationship with adjacent work.
   6. Rigidly mount fan filter units level and plumb with fasteners recommended by manufacturer.
   7. Startup equipment in accordance with manufacturer's instructions.
   8. Seal perimeter of both sides of openings as required.
   9. Record changes to system design that differs from what is shown on drawings.

3.02 CLOSEOUT ACTIVITIES

A. Demonstrate operational system to Owner's representative.

B. Instruct Owner's representative to maintain system and use occupant controls or interfaces, as required.

3.03 PROTECTION

A. Protect installed products until completion of project.

B. Replace, repair, or touch-up damaged products before Substantial Completion.

END OF SECTION 233700

SECTION 234000
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. High-efficiency particulate (HEPA) air filters.

B. High-containment housing for high-efficiency particulate air filter.

1.02 RELATED REQUIREMENTS

A. Section 015000 - Temporary Facilities and Controls: Filters for temporary heating and ventilating.

B. Section 253523 - Integrated Automation Control Dampers: Industrial-grade, bubble-tight dampers.

C. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 850 (I-P) - Performance Rating of Commercial and Industrial Air Filter Equipment; 2013 (Reaffirmed 2023).

B. AHRI 851 (SI) - Performance Rating of Commercial and Industrial Air Filter Equipment; 2013 (Reaffirmed 2023).

C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.

D. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods; 2020b (Validated 2025).

E. UL 586 - High Efficiency, Particulate, Air Filter Units; Current Edition, Including All Revisions.

F. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

G. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

D. Samples: Submit two samples of replacement filter media of each type and each filter frame.

E. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.

F. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

A. American Air Filter Company, Inc; _____: www.aafintl.com/#sle.

B. Camfil, a company of the The Camfil Group; _____: www.camfil.us/#sle.

C. Price Industries,: https://www.priceindustries.com/.

D. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A. Comply with the rating requirements in AHRI 851 (SI).

2.03 HIGH EFFICIENCY PARTICULATE (HEPA) AIR FILTERS

A. Media: UL 586, pleated, water-resistant glass fiber with aluminum separators:
   1. Media to Frame Side Bond: Polyurethane foam.
   2. Face Gasket: Neoprene expanded rubber.

B. Performance Rating:
   1. ASHRAE Std 52.2, Minimum Efficiency Reporting Valve (MERV):
      a. MERV-15, bacteria, smoke, paint, and particles of similar size.
      b. MERV-16, particles between 0.3 to 1.0 micro-meter in size.
   2. Efficiency: 99.97 percent at 0.3 micro-meter and higher when tested in accordance with the DOP-smoke (Dioctyl Phthalate) Penetration Test on MIL-STD-282.
   3. Leakage Scan Tested: Certified as pinhole-free at:
      a. Air velocity capacity of 500 fps (152.4 m/s).
      b. Resistance from 0.5 in-wc (124.3 Pa) to 2.0 in-wc (497.9 Pa).

2.04 HIGH-CONTAINMENT HOUSING FOR HIGH-EFFICIENCY PARTICULATE AIR FILTER

A. Floor-mounted, self-contained high-pressure housing, 11 gauge, 0.125 inch (3.18 mm), 304 stainless steel.

B. Housing-fitted inlet and outlet transitions to flanged bubble-tight isolation dampers in compliance with Section 253523 fitted with pneumatic operator with manual override.

C. Housing to include valved inlet and outlet test ports to sample air stream and inject decontaminating products.

D. Housing to include ribbed banging ring behind filter access door to facilitate the contactless filter bag-in bag-out procedure.

E. Housing-mounted pressure gauge with tubing and fittings per filter section scaled to have highest value at least 2.0 in-wc (0.49 kPa) above maximum rated filter resistance capacity.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION 234000

SECTION 237416
PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged, intermediate-capacity, rooftop air-conditioning units.

1.02 RELATED REQUIREMENTS

A. Section 061000 - Rough Carpentry: Materials and installation of field fabricated roof mounting curbs.

B. Section 076200 - Sheet Metal Flashing and Trim.

C. Section 077200 - Roof Accessories: Placement and installation of factory fabricated roof mounting curbs.

D. Section 230548 - Vibration and Seismic Controls for HVAC.

E. Section 230913 - Instrumentation and Control Devices for HVAC: Control components, time clocks.

F. Section 234000 - HVAC Air Cleaning Devices.

G. Section 260583 - Wiring Connections: Installation and wiring of thermostats and other control components; wiring from unit terminal strip to remote panel.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.

C. AMCA 611 - Certified Ratings Program - Product Rating Manual for Airflow Measurement Stations; 2015.

D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2024.

F. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020, with Amendment (2023).

G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Filters: One set for each unit.

1.05 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.

B. Trane Technologies, PLC; _____: www.trane.com/#sle.

C. Aaon

2.02 PACKAGED, INTERMEDIATE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Manufacturers:
   1. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.
   2. Trane Technologies, PLC; _____: www.trane.com/#sle.
   3. Aaon
   4. Substitutions: See Section 016000 - Product Requirements.

B. General: Roof mounted units having gas burner and electric refrigeration that are 7.5 tons to 25 tons in capacity.

C. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.

2.03 CASING

A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver-operated flush, cam type fasteners. Structural members to be minimum 18 gauge, 0.0478 inch (1.21 mm), with access doors or panels of minimum 20 gauge, 0.0359 inch (0.91 mm).

B. Insulation: 2-inch (50 mm) thick, neoprene-coated glass fiber with edges protected from erosion.

2.04 FANS

A. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch pulley, and rubber isolated hinge mounted. Provide with high efficiency motor or direct drive as indicated. Isolate complete fan assembly. See Section 230548.

2.05 BURNERS

A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff pilot.
   1. Construction: Welded stainless steel.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature, and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.06 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons (21 kw) capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons (26 kw) cooling capacity and larger.

2.07 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

C. Provide refrigerant pressure switches to cycle condenser fans.

2.08 HEAT RECOVERY COIL

A. Provide copper tube aluminum fin coil assembly with multiple circuits arranged to provide heat recovery.

2.09 COMPRESSORS

A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

B. Five minute timed off circuit to delay compressor start.

C. Provide step capacity control by cycling multi-speed compressors.

D. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.10 MIXED AIR CASING

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2-inch (500 Pa) pressure differential.

C. Damper Operator, Units 7.5 Ton (26 kW) Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.

2.11 AIR FILTERS:

A. 2-inch (50 mm) thick, glass fiber disposable media in metal frames.

2.12 AIRFLOW MEASUREMENT

A. Manufacturers:
1. KMC Controls; Conquest Airflow Measurement System: www.kmccontrols.com/#sle.
2. Paragon Controls, Inc; _____: www.paragoncontrols.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

B. Airflow Meter:
1. Provide airflow measurement system to directly measure fan airflow or measure differential pressure that can be used to calculate airflow without interfering with submitted airflow performance and noise levels.
2. Accuracy: Plus or minus five percent when operating within stable operating region of fan curve.

C. Airflow Measurement Station:
1. Provide factory-installed airflow measurement station tested in accordance with AMCA 611 and bearing AMCA Ratings Seal for Airflow Measurement Performance.
2. Station Location: Install in outdoor and return openings to measure airflow.
3. Damper Blades:
a. Galvanized steel or extruded aluminum construction.
b. Housed in galvanized steel or extruded aluminum frame and mechanically fastened to a rotating axle rod.
c. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
4. Measurement Range: Minimum of 15 percent to 100 percent of unit nominal flow.
5. Operation: Provide low voltage signal corresponding to actual airflow for controlling and documenting airflow.
6. Accuracy: Plus or minus 5 percent.

2.13 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air to signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section to operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F (24 degrees C) as determined by enthalpy of return and outdoor air.

B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

C. Control logic to allow supply air reset under low load or airflow conditions.

2.14 ROOF CURBS

A. Roof Mounting Curb: 14 inches (350 mm) high, galvanized steel, channel frame with gaskets, nailer strips.

B. Vibration Isolation Curb: _____.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as required by manufacturer.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. See Section 017900 - Demonstration and Training for additional requirements.

B. Demonstrate proper operation of equipment to Owner's designated representative.

3.05 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of packaged rooftop units for one year from Date of Substantial Completion.

C. Provide routine maintenance service with a two-month interval as maximum time period between calls.

D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

E. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 237416

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SECTION 237433
DEDICATED OUTDOOR AIR UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof-mounted DOAS.

1.02 RELATED REQUIREMENTS

A. Section 230513 - Common Motor Requirements for HVAC Equipment.

B. Section 230548 - Vibration and Seismic Controls for HVAC.

C. Section 230923 - Direct-Digital Control System for HVAC.

D. Section 230934 - Variable-Frequency Motor Controllers for HVAC.

E. Section 233300 - Air Duct Accessories: Flexible duct connections.

F. Section 251400 - Integrated Automation Local Control Units.

G. Section 251500 - Integrated Automation Software.

H. Section 251400 - Integrated Automation Local Control Units.

I. Section 251500 - Integrated Automation Software: BAS, BMS, or SCADA.

J. Section 253500 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

K. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.

C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.

D. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.

E. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

H. UL (DIR) - Online Certifications Directory; Current Edition.

I. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

G. Project Record Documents: Record actual locations of components.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements for additional provisions.
   2. Extra Filters: One set of each type and size.

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturers warranty for compressor/condenser unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Greenheck: www.greenheck.com/#sle.

B. Trane, Inc. https://www.trane.com/

C. Aaon, Inc. Basis of Design.

D. Scott Springfield

E. Nortek Solutions, Inc.

F. Substitutions: See Section 016000 - Product Requirements.

2.02 ROOF-MOUNTED DOAS

A. Packaged Unit:
   1. Casing and Components:
      a. Fabrication: AHRI 210/240 and UL 207 construction, ASHRAE Std 23 tested.
      b. 18 gauge, 0.0478 inch (1.21 mm) steel panels reinforced with structural angles and channels to ensure rigidity.
      c. Provide bolted access panels to access each sections from either side of unit.
      d. Provide hinged door with lockable handle for serviceable sections.
      e. Drain Pan: Stainless steel with corrosion-resistant coating.
   2. Performance Ratings: ASHRAE Std 90.1, EER and COP as applicable.
   3. Regulatory Requirements: AHRI 270 (SI/I-P) rated, NFPA 70, and UL (DIR) listed.
   4. Insulation: Minimum () thick acoustic duct liner for lining cabinet interior.
   5. External Surface Finish: Heat resistant baked enamel.
   6. Outdoor Installation: Weatherproofed casing, with intake louver or hood.
   7. Outside Air Damper with Rain Hood and Screen:
      a. Set outdoor air dampers to fully open when fan starts and close 30 seconds after fan stops, adjustable.

B. Filter Section:
   1. Filter: Removable, 4 inches (100 mm) thick combined MERV-8 and MERV-14.
   2. Monitoring: Provide gauge with loaded setpoint-adjustable signal flag or external tag. Provide loaded filter alarm switch wired into unit controls with illuminated indicator on local control panel face.

C. Heating Section:
   1. Indirect Gas-Fired Furnace:
      a. Fully sealed natural gas burning assembly configured for modulated 25:1 turn down ratio using electrically operated devices including modulating main gas valve, shut down valve, main gas, and pilot gas regulators. Manual main gas shut-off valve and pilot adjustment valve.
      b. Insulation: Neoprene faced glass fiber insulation, 1 inch (25 mm) thick, on inlet components to burner profile plate.
      c. Observation Port: On burner section for observing main and pilot flames.
      d. Pilot: Electrically ignited by spark rod through high voltage ignition transformer.
      e. Damper: Motorized with end switch to prove position before burner will fire.

D. Cooling Section:
   1. Packaged DX Cooling:
      a. Configuration: AHRI 520-rated, R-454B refrigerant system with hot gas bypass.
      b. Evaporator Coil: Copper tube aluminum fin coil assembly with alternate row circuiting, and with galvanized drain pan and thermostatic expansion valve.
      c. Compressor: One hermetic single-stage scroll or reciprocating, 3,600 rpm maximum resilience with positive lubrication, crankcase heater, high pressure control, low pressure control, motor overload protection, service valves and dryer.
      d. Condenser Side: Aluminum fin and copper tube coil, direct drive axial fan resiliently mounted, galvanized fan guard. ECM condenser fans.
      e. Operating and Safety Controls: Internally coordinated with main unit controls.

E. Enthalpy Economizer Section: Provide factory-installed sensors, electrically-actuated return air damper, and electrically-actuated exhaust damper fully coordinated with return, exhaust, or return-exhaust fan section. Configure controls for fault-detection diagnostics.

F. Fan Section:
   1. Provide direct or plenum mounted variable-speed fan motors; see Section 230513.
   2. Draw-through, backward-curved fan, constructed of corrosion-resistant, galvanized material and designed for efficient, quiet operation.
   3. Factory program for both soft start and constant flow output over static pressure range.
   4. Provide preinstalled neutral wire protection when required to support specified fan type.
   5. Motor to include thermal overload protection, quick disconnect plug, and permanently lubricated bearings.
   6. Belt-Driven Motor Requirements: Provide adjustable blower motor/sheave combination device based on indicated flow performance requirements. Statically and dynamically balanced centrifugal fan mounted on solid steel shaft with heavy-duty, self-aligning, prelubricated ball bearings and V-belt drive with matching motor sheaves and belts.
   7. Variable Speed Control: Configure controller to maintain adjustable flow setpoint for modulating or speed-switched units; see Section 230934.
   8. Fan Turndown: Design control features to allow fan speed reduction to adjustable 50 percent of its capacity when the zone set point temperature is satisfied or when unit runs in fan-only mode.

G. Unit Controls:
   1. DDC:
      a. Application Specific Controller; see Section 251400 unless factory-provided.
      b. Tested to monitor and handle sequencing functions and other operational modes using field-mounted thermostat and other sensors.
      c. Coordination and Sequencing:

1) Internal Devices: Include compressors, blower, sensors, switches, valves, safeties, other components.
2) Field-Installed Devices: Solenoid valves, thermostat, EWT sensors, LWT sensors, internal and remote contacts, and other devices required for operation.
3) Safeties: At minimum include anti-short-cycle compressor protection, condensate overflow, refrigerant high pressure, refrigerant low pressure, loss-of-charge, refrigerant freeze protection, and freezestat.

2. Thermostat:
   a. Field mounted and wired, tied into prewired control-interface terminals.
   b. Smart Thermostat:
      1) BAS, SCADA, or Integrated Automation linked programmable thermostat; see Section 251400.
   c. Programmable Thermostat:
      1) Electro-mechanical type with key- or pushbutton-operated display.
      2) Programmable occupied/unoccupied weekly and holiday schedule.
   d. Nonprogrammable Thermostat:
      1) Electro-mechanical type with key- or pushbutton-operated display.
      2) User-configurable, precoded options aligned with equipment functions.
   e. Thermostat: Single-gang-box-mounted platinum or thermistor.
      1) Local Interface to Include:
         (a) Filter maintenance indicating status.
3. Airflow Meter:
   a. Include integral airflow meter station or probe for ventilation, supply, or exhaust airflow in cfm (L/min) as indicated on drawings.
   b. Mount monitor gauge parallel to airflow meter on unit exterior and make casing connection watertight.
   c. Products:
      1) Air Monitor, a brand of Onicon, Inc: www.onicon.com/#sle.
      2) Paragon Controls, Inc: www.paragoncontrols.com/#sle.
4. Local Control Panel: Interface to include on-off-auto switch, summer-winter switch, heat-off-cool switch, indicating lights for supply fan, pilot operation, burner operation, lockout indication, and clogged filter indication.
5. Interlocked Functions:
   a. Unit to start when exhaust fan is running.
   b. Low and High Limit Controls: Maintain supply air temperature between set points and shut fan down if temperatures are exceeded. Include manual reset switch.

H. Electrical: 480 VAC, 3-phase, 60 Hz, single point to factory-mounted nonfused disconnect switch internally wired into motors and compressors, and other powered components including system safeties.

I. Furnish dedicated outdoor air unit and associated components and accessories produced by a single manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide unit- or duct-mounted smoke detectors and other NFPA 90A provisions.

C. Install unit on vibration isolator pad or roof curb; see Section 230548.

D. Provide flexible duct connections on inlet and outlet from unit; see Section 233300.

E. Connect drain pan outlet to nearest building drain system piping.

F. Adjusting: Use plenum static pressure readings against manufacturer calibration chart to adjust primary airflow as other measuring methods will not work.

G. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

3.02 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Provide service and maintenance of units for one year from Date of Substantial Completion.

END OF SECTION 237433