ADDENDUM "B"

Date: January 20, 2023
Project: **GCPL Xenia Community Library Renovation**
76 East Market Street
Xenia, OH 45385

Documents prepared by K4 Architecture, LLC of Cincinnati, OH, Enhanse, LLC of Norwood, OH, Advantage Group Engineers of Cincinnati, OH dated 01/04/2023.

A. TO ALL BIDDERS:

This addendum is part of the contract documents. Changes shall be taken into account by the bidders in preparing their proposal. Bidders shall verify this by indicating receipt of this addendum in their bids.

B. INTENT AND SCOPE:

This addendum, issued before the receipt of proposals, is intended to provide additional information, answer questions raised by prospective bidders and to clarify or revise the requirements of the contract documents.

C. CLARIFICATIONS

1. The building will be open **Thursday, January 26th from 9:00 AM to 10:00 AM** (before operating hours) for continued contractor investigation of the project site. Contractors shall enter the employee entrance off the main parking lot.
2. The Project Manual has been updated. Where omitted, specific manufacturers (specs) will be identified in a future addendum. Quantities are on the drawings.
3. Ceiling finish plans will be issued in a future addendum.

D. UPDATED DRAWING/SPECIFICATION LIST:

- **DRAWINGS**
  - T001
  - PH001
  - PH002
  - PH003
  - LS101
  - LS102
  - S110
  - S120
  - S130
  - S310
  - S311
  - S320
  - S321
  - S322
  - S323
  - D101
  - D102
  - D401
  - D402
  - A001
  - A101
  - A102
  - A111
  - A201
  - A202
  - A203
  - A204
  - A205
  - A309
  - A506
  - A601
  - A602
  - A603
  - I101
  - I102
  - I103
  - I503

- **SPECIFICATIONS**
  - 012100 ALLOWANCES
  - 044311 LIMESTONE MASONRY VENEER
  - 051200 ROOF LADDERS
  - 055000 METAL FABRICATIONS
  - 057300 ALUMINUM RAILING
  - 074113 STANDING-SEAM METAL ROOF PANELS
  - 075423 THERMOPLASTIC MEMBRANE ROOFING
  - 080911 GLAZED ALUMINUM CURTAIN WALL
  - 084113 ALUMINUM FRAMED STOREFRONT
  - 095126 ACOUSTIC WOOD CEILING
  - 095813 MONOLITHIC CEILING SYSTEM
  - 104413 FIRE PROTECTION CABINETS
  - 104416 FIRE EXTINGUISHERS
  - 107320 CANOPIES
  - 142410 ELEVATOR MODERNIZATION
  - 323500 SITE SCREENING DEVICES
  - Division 23 SPECIFICATIONS

E. RFI's

1. **Is there a Division 23 Spec?**
   a. This has been issued as of Addendum B.

2. **Is the sidewalk staying on Whiteman?**
   a. Portions of the sidewalk will be widened. Please refer to C200 for the extent of sidewalk demolition and reconfiguration along Whiteman.

3. **Where will dumpsters be allowed/staging?**
   a. We have identified portions of the parking lot/sidewalk along Whiteman that will be designated for construction personnel. A 'proposed construction site plan' will be issued in the next Addendum.

4. **Are we required to use Johnson Controls for HVAC?**
   a. No. A qualified temperature controls contractor is to be employed to provide a new control system utilizing the existing operator workstation and head-end software as described in specification section 230923. Multiple manufacturers are listed to accommodate competitive bidding, and the new control system controllers, input and output devices, I/O modules, will utilize open network communication protocol (BACNet per ASHRAE Standard 135) and will communicate completely with the existing operator workstation and head-end software. The existing head-end software (Honeywell) was recently updated by the owner, and is software that communicates utilizing this open protocol.

END OF ADDENDUM "B"

21-2113 – GCPL Xenia Community Library Renovation

ADDENDUM B

MEETING MINUTES - 10:30 AM, Thursday, January 12, 2023 @ project site

Items specifically discussed are shown highlighted. The following is assumed to be a complete and correct account of the items discussed, directions given, and conclusions drawn, unless this office is notified to the contrary within 72 hours. If no notification is received, these minutes will be deemed an accurate account of the meeting.

A. Introductions and Sign in – KC/RP/BB

1. Greene County Public Library (GCPL)
   a. Karl Colon, Executive Director (KC)
   b. Elizabeth Cusack, Deputy Director (EC)
   c. Ted Doggett, Operation's Manager (TD)
2. Architect, K4 Architecture, LLC (K4)
   a. Richard S. Posey, Principal Architect (RP)
   b. Brian Bruner, Jr., Project Manager (BB)

B. Bid Submission - BB

1. **There will be an Addendum issued Friday to reflect the following changes** *(Note: The Addendum was subsequently advised to be delayed; the Advertisement was updated in the paper on Friday as relayed)*
   a. Before **12:00 PM (noon), Wednesday, February 22, 2023**
   b. Submit to: Board of Trustees, Greene County Public Library, 76 East Market Street, Xenia, OH 45385.
   c. Drawings will be submitted to the Admin Office suite on the 2nd floor and be date stamped.
   d. Please refer to the Project Manual for submission requirements.

C. Scope of the Project - BB

1. General Contract
   a. Base Bid: Complete renovation and mechanical upgrades for the Xenia Community Library per drawings and specs

D. Schedule - BB

1. Review Schedule
   a. Early April – Anticipated issuance of Notice to Proceed
   b. Length of Contract: Refer to Section 00 41 13-2. 20 Months.
      1) Building Permit will be filed with the City of Xenia once the transition of jurisdiction is complete from Greene County

E. Bid Format - BB

1. Refer to Section 00 22 13 - 2 – Supplementary Instructions to Bidders, Article 9.0.

F. Site Issues / Logistics – KC/EC/TD/RP/BB

1. There are two scheduled days to access project site:
   a. Today, 1/12/2023 and Thursday, 1/19/2023 @ 9:00 AM
   b. Please contact Brian Bruner (Section: 01 10 00) for subsequent access into the facilities. Contractors and subs are not allowed to visit unannounced.
   c. If there are enough contractors that want to come on a particular day, we will send out a notice that the building will be made available for that particular day.
2. Review sanitary facilities:
   a. GC and construction personnel are not to use sanitary facilities during construction (reason doing so is that full time janitorial staff would most likely not be servicing the GC's restrooms)
3. Review waste disposal facilities:
   a. GC is responsible for removal of all construction waste from project site
4. Storage of materials:
   a. GC is responsible for storage of all construction materials
5. Parking:
   a. The GC shall be allowed to park on the southern half and east side of the parking lot. GC shall maintain access for GCPL movers at rear dock during Phase 1. GC shall coordinate with GCPL staff as outlined in Project Manual.

G. RFI's - BB

1. All RFI's are to be sent in writing to Brian Bruner, Jr. with K4 Architecture
2. Deadline for submitting an RFI is **12:00 PM, Friday, February 10, 2022.**

H. Addenda - BB

1. Deadline to issue Final Addendum is 12:00 PM, Friday, February 17, 2023.
   a. (3) days prior to opening of bid

I. Additional comments from Greene County Public Library – KC/EC/TD

J. Site Inspection - All

1. Tour of project areas.
   a. Review of Schedule of Alternates (during tour):
      1) Alternate #1: bollards and heavy-duty pavement
      2) Alternate #2a (Deduct Alternate): Omit two (2) eastern "bump-outs"
      3) Alternate #2b (Deduct Alternate): Omit three (3) southern "bump-outs"
      4) Alternate #3: Demolish and replace CMU and curtain wall at YS Atrium
      5) Alternate #4: Replace existing second-floor single windows (count: 21)
      6) Alternate #5: 3M security film to first floor windows

ADJOURN

SECTION 00 01 10 - TABLE OF CONTENTS

1.1 SPECIFICATIONS DATE

A. These specifications have been produced at the date indicated in the header of each particular section. Any modifications to occur within each section will be reflected by the date to be updated and indicated in the Revision Date column included in this Table of Contents. The current issue date for all the spec sections is indicated on the cover of the Project Manual and this Table of Contents.

1.2 PROJECT LOCATION

A. Project Location:

Greene County Public Library
Xenia Community Library Renovation
76 East Market Street
Xenia, OH 45385

1.3 TABLE OF CONTENTS

AIA FORMS REFERENCED IN THIS PROJECT MANUAL:

SPECIFICATIONS GROUP

GENERAL REQUIREMENTS SUBGROUP

SITE AND INFRASTRUCTURE SUBGROUP

PROCESS EQUIPMENT SUBGROUP – Not Used

END OF SECTION 00 01 10

SECTION 01 21 00 – ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.

C. Related Sections:

1. Division 01 Section "Unit Prices" for procedures for using unit prices.
2. Divisions 02 through 49 Sections for items of Work covered by allowances.

1.3 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.4 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.5 LUMP-SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include [taxes,]freight[,] and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.6 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Allowance #1 – Permits Allowance: Include an allowance of $10,000.00 for necessary permitting required as a result of the project scope.

B. Allowance #2 – Testing and Inspection Allowance: Include an allowance of $15,000.00 necessary testing and Inspection Services required as a result of the project scope.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

C. Allowance #3 – Building Commission Allowance: Include an allowance of $15,000.00 required building commissioning.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

D. Allowance #4 – Concrete Floor Prep Allowance: Include an allowance of $10,000.00 to prep the first and second floors for new finishes by the others.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

E. Allowance #5 – Architectural Casework Allowance: Include an allowance of $25,000.00 for new casework required by project scope (10K first floor, 15K second floor).

1. Where shown on drawings for new casework and countertops to be installed. This allowance includes material and labor only. This allowance does not include required blocking as described on plans.

F. Allowance #6 – Loading Dock Canopy: Include an allowance of $15,000.00 for a pre-engineered metal canopy at the loading dock.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit. Permitting fees associated with the canopy are covered by this allowance.

G. Allowance #7 – Roller Window Shades Allowance: Include an allowance of $25,000.00 for the purchase and installation of roller window shades for the project (specific locations and products to be identified on a future Addendum).

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

H. Allowance #8 – Elevator Modernization: Include an allowance of $125,000.00 for elevator upgrades as described in Section 14 24 10 Modernization of Hydraulic Elevator.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

I. Allowance #9 – Exterior Lighting Façade/Bollard Allowance: Include an allowance of $20,000 for exterior accent lighting to the project site e.g., parking lot, landscape, building (specific locations to be identified on a future Addendum).

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit.

J. Allowance #10 – 20” Barrier Curbs: Include an allowance of $5,000.00 for use of 20” Barrier Curbs.

1. This allowance includes the use of barrier curbs as necessary during various construction phases e.g. picking limestone panels, etc.

K. Allowance #11 – Landscaping Allowance: Include an allowance of $15,000.00 for landscaping as shown on the Landscape Plan L-001.

1. This allowance includes labor, material cost receiving, handling, and Contractor overhead and profit. This does not include scope of work for demolition of existing landscaping items.

END OF SECTION 01 21 00

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SECTION 04 31 11 – LIMESTONE MASONRY VENEER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Modular limestone masonry veneer units and accessories

1.3 RELATED SECTIONS

A. Section 07 01 91 – Joint sealants rehabilitation and replacement

B. Section 07 62 00 – Water repellents

1.4 DEFINITIONS

A. ACI – American Concrete Institute (www.concrete.org).

B. AISC – American Institute of Steel Construction (www.aisc.org).

C. ASTM – American Society for Testing and Materials (www.astm.org).

D. AWS – American Welding Society (www.aws.org).

E. ILIA – Indiana Limestone Institute of America (www.iliai.com).

F. IMI – International Masonry Institute (imiweb.org).

1.5 REFERENCE STANDARDS

A. ASTM C568/C568M – Standard Specification for Limestone Dimension Stone; 2015.

B. ASTM C1242 – Standard Guide for Selection, Design, and Installation of Dimension Stone Attachment Systems; 2015a.

1.6 COORDINATION

A. Coordination: Coordinate limestone masonry veneer assemblies with rain drainage, flashing, sills and trim, and other adjoining work.

1.7 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data sheets including certified laboratory test reports for limestone, accessories, and other products required.

B. Shop Drawings: Submit fabrication and installation layouts of limestone masonry units; including exterior elevations, details of edge conditions, joints, profiles, corners, sills, anchorage and attachment system, trim, flashings, closures, accessories, and special details.

1. Include in shop drawings details as developed by cladding engineer in accordance with specified requirements.
2. Include mechanical anchoring and framing of preassembled units showing epoxy joint construction.

C. Samples: Submit two or samples for each type of limestone masonry required, at least 12 inch (305 mm) high by 12 inch (305 mm) wide by 1 inch (25.4 mm) thick.

D. Sets of samples to represent range of variations in color and finish as expected in completed work.

E. Submit samples of joint sealants for each type and color required.

F. Delegated Design Submittals: Submit the following data on limestone that has been signed and stamped by Professional Engineer registered in state the project is located who certifies preparing or supervising the preparation of design data in compliance with specified performance requirements and recognized engineering principles and practices.

1. Engineering calculations.
2. Connection details.

G. Test and Evaluation Reports: Submit on each type of limestone masonry system provided for project based on evaluation of comprehensive tests performed by qualified testing agency.

H. Qualification Statements: Submit evidence of qualifications as indicated.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Sample Warranties: For special warranties.

1.9 QUALITY ASSURANCE

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

B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.

C. Testing Agency Qualifications: Contractor to engage independent testing laboratories to perform preconstruction testing.

1. Test limestone for compliance with specified performance requirements.
2. Conduct tests using specimens randomly selected from proposed materials designated for use in this work.

D. Welder Qualifications: Company with welding operators qualified for processes required for this work in accordance with AWS standard qualification procedures.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials and products in strict compliance with manufacturer's instructions, recommendations, and industry standards.

B. Store and handle stone and related materials to prevent deterioration and damage.

1. Do not use pinch or wrecking bars on stonework.
2. Lift limestone using wide-belt type slings where possible; do not use wire ropes, or ropes containing tar or other substances that may cause staining.
3. Store limestone on non-staining wood skids or pallets, and cover with non-staining, waterproof membrane.
4. Place and stack skids and limestone to distribute weight evenly and to prevent breakage or cracking of limestone.
5. Store cementitious materials above ground or floor, under cover, and in dry location.

1.11 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress

1.12 PROJECT CONDITIONS

A. Cold Weather Protection: Comply with IMI - Cold Weather Masonry Construction and Protection Recommendations (www.imiweb.org/cold-weather-masonry-construction).

B. Protect limestone masonry work during construction as follows:

1. Cover top of walls with non-staining waterproof sheeting at end of work each day.
2. Cover partially completed stonework while work is not in progress.
3. Extend cover at least 24 inches (610 mm) down both sides and hold securely in place.
4. Prevent staining of stone from mortar, grout, sealants, and other materials; immediately remove such materials from stone without damaging stonework.
5. Protect base of walls from rain-splashed mud and mortar splatter using approved coverings spread on ground and applied over wall surface.
6. Protect sills, ledges and projections from droppings of mortar and sealants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide product by the following:

1. Indiana Limestone Company
   a. 123 South College Av. Bloomington, IN 47404
   b. Rep: Dan Ouellette, 812-278-6458, dan.ouellette@polycor.com

2. Architect approved equal

2.2 MATERIALS

A. Limestone: Complies with ASTM C568/C568M, Type II (Medium Density) Classification.

1. Variety: Indiana Limestone.
2. Absorption by Weight: 7.5 maximum percentage; ASTM C97/C97M.
3. Density: 135 lbs/cu ft (2160 kg/cu m), minimum; ASTM C97/C97M.
4. Compressive Strength: 4000 psi (28 MPa), minimum; ASTM C170/C170M.
5. Modulus of Rupture: 700 psi (3.4 MPa), minimum; ASTM C99/C99M.

2.3 PRODUCT TYPES

A. Type (Match Existing) - Vanderbilt Classic Smooth:

1. Finish: Smooth face with sawn top, bottom, back, and each end.
2. Color: Match existing (gray).
3. Panel Size: Refer to Drawings, match existing spacing, orientations, and configurations.
4. Thickness: 3-5/8 inch (92 mm).

2.4 PERFORMANCE REQUIREMENTS

A. Physical Properties: Provide limestone with physical properties that meet or exceed values listed in ILIA Indiana Limestone Handbook, latest edition.

B. Safety Factors: Provide safety factors for design loads and stresses of limestone masonry assembly that meet or exceed values indicated in ILIA Technote on Safety Factors.

C. Limestone Connections and Attachments: Design steel supports, shapes, plates, bolts, and attachments to support design loads with safety factors and allowable stresses in accordance with ASTM C1242 and AISC Steel Construction Manual, latest edition, and the following.

1. Do not stress steel supports carrying gravity loads more than 50 percent of yield stress in bending.
2. Welds: Comply with AWS D1.1/D1.1M.
3. Concrete Embedded Items: Comply with ACI or manufacturers recommendations, with safety factor not less than 4 to 1 based on concrete failure.

D. Design Loads: Design cladding and cladding attachments in compliance with following design loads with safety factors as specified.

E. Wind Loads, Dead and Live Loads: Comply with local building code requirements and authorities having jurisdiction.

F. Corrosion and Stain Control: Prevent galvanic and other types of corrosion or staining by isolating metals and other materials from direct contact with incompatible materials, or by applying suitable coatings; staining of stone and joint surfaces is not permitted.

2.5 STONE ANCHORS AND ATTACHMENTS

A. Provide anchors and attachments of required type and size to support stonework and fabricated from following materials for conditions indicated:

1. Anchors and Expansion Bolts Embedded in Stone: Stainless steel, Types 304 or 316.
2. Adjustable Inserts Embedded in Concrete: Galvanized malleable iron.
3. Anchor Bolts, Nuts and Washers Not in Direct Contact with Stone: Comply with ASTM A307, Grade A materials; galvanized in accordance with ASTM A153/A153M, Class C.
4. Steel Plates, Shapes and Bars Not in Direct Contact with Stone: Comply with ASTM A36/A36M for materials; galvanized in accordance with ASTM A123/A123M.
5. Expansion Bolts Not in Direct Contact with Stone: Zinc plated or cadmium plated bolts with stainless steel expansion clips.
6. High Strength Threaded Bolts: Comply with ASTM F3125/F3125M
7. Steel Angles Supporting Stone: Comply with ASTM A36/A36M for materials; galvanized in accordance with ASTM A123/A123M.
8. Upon approval from Architect; protect supports with one shop coating of zinc-rich or other rust-inhibiting paint, and one field coat of similar compatible paint.

B. Dovetail Slots: Provide dovetail slots with filler strips, and slot sized to receive anchors; with at least 22 gage, 0.0336 inch (0.85 mm) thick galvanized steel sheet, ASTM A653/A653M, G90 Coating Designation.

2.6 FABRICATION

A. Fabricate limestone masonry in sizes and shapes as necessary and in compliance with requirements indicated on approved shop drawings.

B. Comply with written recommendations of the ILIA - Indiana Limestone Handbook, latest edition.

C. Cut and drill depressed areas and holes in stones for anchors, fasteners, supports, and lifting devices as indicated or as necessary to set stonework securely in place; shape beds to fit supports.

D. Cut stones to fabricate pieces of thickness, size, and shape as indicated or required for this Work within fabrication tolerances recommended by ILIA - Indiana Limestone Handbook, latest edition.

E. Tolerances: Provide connections that allow for fabrication, erection, and structural deflection tolerances; refer to Sections 03 3000 and 05 1200 for additional requirements.

F. Fabricate stone to thicknesses required in compliance with performance requirements, but not less than as shown on drawings; use tables in ILIA - Indiana Limestone Handbook, latest edition, as a guide for size requirements.

G. Control depth of stone and check to maintain suitable clearance between backside of stone and surfaces and projections of structural members, backup walls, and other substrate related work.

H. Fabricate bed and vertical joints straight and at 90 degree angle to stone face, unless noted otherwise, of uniform width and at locations indicated.

1. Joint Width: Match Existing.

I. Fabricate quirk-miter corners, unless noted otherwise, and provide for U-bar cramp anchors in top and bottom bed joints of corner pieces.

J. Fabricate chases, reveals, reglets, openings, and other similar features as required to accommodate unbroken sequence of contiguous stone work.

K. Finish exposed faces and edges of stones in compliance with indicated requirements for finish under each type and application of stone required and to match approved samples

2.7 ACCESSORIES

A. Sealants: Refer to Section 07 01 91.

B. Setting Shims: Sized to suit stone joint thicknesses and bed depths without intruding into depths required for joint sealants.

1. Materials: Lead, stainless steel, or plastic shims; non-staining to limestone.

C. Concealed Flashing: Fabricate from materials as indicated in Section 07 62 00, with minimum thickness of 0.015 inch (0.38 mm).

D. Weeps: Provide medium density polyethylene plastic tubing weeps, 1/4 inch (6.4 mm) outside diameter and length as required to extend from interior cavity out to exterior face of limestone.

E. Weather Resistant Barrier (WRB): Provide WRB in compliance with local building code and the authorities having jurisdiction within wall assembly to control condensation and other moisture in wall.

1. Refer to Section 07 25 00 for additional requirements.

F. Drainage Mats: Provide drainage mats in compliance with local building code and the authorities having jurisdiction within wall assembly to allow moisture to flow downward and out weeps system providing a rapid drying capacity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive limestone masonry and conditions under which limestone masonry will be installed, with Installer present, for compliance with specified requirements.

B. Submit written report, validated by Installer, listing any conditions that are not in compliance with specified requirements.

C. Do not proceed with installation until surfaces and conditions comply with specified requirements for limestone masonry or other related work that affects this Work.

3.2 PREPARATION

A. Advise installers of related work about specific requirements for proper placement and installation of inserts, flashing reglets, and other necessary items to be used for anchoring, supporting, and flashing of this Work.

1. Provide installers of related work with drawings or templates showing proper locations of these items.
2. Installer of weld-plates and other embedded materials used for connection of limestone masonry to provide drawings to installer of limestone masonry work indicating accurate locations of these materials.

B. Prior to setting, clean limestone surfaces that have become dirty or stained by removing soil, stains, and other foreign materials.

1. Thoroughly clean limestone by scrubbing stones with fiber brushes followed by thorough drenching with clean clear water, and using only mild cleaning compounds that do not contain any acids, caustic or abrasive materials.

3.3 INSTALLATION

A. Setting Limestone with Sealant Joints:

1. Support limestone masonry work on gravity supports, and insert anchors for support of lateral loads of type and quantity as indicated on approved shop drawings in compliance with requirements.
2. Securely attach anchors to limestone and backup substrate surfaces.
3. Attach framing for limestone masonry support system to structural frame of building at connection locations indicated by welded or bolted field connections in compliance with the following requirements:

    a. Install high strength threaded fasteners or anchor bolts in compliance with AISC recommendations.
    b. Provide joints that allows water to drain to exterior face of building, and provide weeps at locations where water may accumulate due to condensation or for other reasons.
    c. Galvanized Surfaces: Comply with ASTM A780/A780M for cleaning field welds, bolted connections and abraded areas, and for applying galvanizing repair paint to surfaces of assembled framing.
    d. Shop Painted Surfaces: Clean field welds, bolted connections, and abraded areas immediately after erection, and apply paint to exposed areas using same materials as used for shop painting.

4. Fill anchor holes with non-staining mortar or sealant, and where dowels occur at pressure-relieving joints, provide compressive material above and below dowels.
5. Limestone Supported on Clips or Continuous Angles: Set limestone on non-corrosive and non-staining shim material with sufficient area to support load; mortar may be used in lieu of shims provided that setting pads are provided to maintain joint sizes needed if weight of stone squeezes out mortar.

    a. Locate setting buttons of adequate size, in sufficient quantity, and of uniform thickness as indicated joint width, to prevent mortar from squeezing out and to maintain uniform joint widths.
    b. Place setting buttons back from face of stone to provide space for backer rod and sealant.
    c. Provide joint free of mortar or shims between bottom of relieving angles and top surface of stones below angles to avoid transfer of loads.

6. Install concealed flashing at continuous shelf angles, lintels, ledges and similar obstructions to maintain downward water flow and to divert such water to exterior side.
7. Maintain open cavities between back of stone veneer and backup substrate wall; do not fill cavities with mortar or grout.
8. Install weepholes/vents in joints where moisture may accumulate including base of cavity walls, above shelf angles and flashing.

    a. Locate weepholes/vents at intervals of not more than 2 feet (0.61 m).
    b. Locate vents at intervals of not more than 5 feet (1.5 m) horizontally and 20 feet (6.1 m) vertically.

9. At locations that mortar is used in setting stones on anchors, or other locations, rake out mortar from joints to depth necessary for placement of backer rod and sealant.
10. Embed ends of lugged sills on shims or mortar, and leave balance of joint open until final sealing.
11. For installation of joint sealants, set the stonework with open vertical joints, do not use shims or spacers in these vertical joints.
12. Install sealants and joint systems in compliance with ILIA - Indiana Limestone Handbook, latest edition, and refer to Section 07 9200 for additional requirements.
13. Movement Joints: Provide 3/8 inch (9.5 mm) minimum width, 1/2 inch (12.7 mm) maximum width concave movement joints, unless otherwise noted, and located as indicated on drawings.

3.4 TOLERANCES

A. Variations from Plumb:

1. For lines and surfaces of columns, walls or other vertical surfaces, do not exceed:
   a. 1/4 inch in 10 feet (6.4 mm in 3 m).
   b. 3/8 inch (9.5 mm) in story height, 20 feet (6 m) maximum.
   c. 1/2 inch in 40 feet (12.7 mm in 12.2 m) or more.
2. For external corners, expansion joints and other conspicuous lines, do not exceed:
   a. 1/4 inch (6.4 mm) in any story, 20 feet (6 m) maximum.
   b. 1/2 inch in 40 feet (12.7 mm in 12.2 m) or more.

B. Variations from Level:

1. For exposed lintels, sills, parapets, horizontal grooves or other horizontal surfaces, do not exceed:
   a. 1/2 inch (12.7 mm) in any bay, 20 feet (6 m) maximum.
   b. 3/4 inch in 40 feet (19 mm in 12.2 m) or more.

C. Variations of Linear Building Lines:

1. For positions shown in plan on drawings and related portion of columns, walls and partitions, do not exceed:
   a. 1/2 inch (12.7 mm) in any bay, 20 feet (6 m) maximum.
   b. 3/4 inch in 40 feet (19 mm in 12.2 m) or more.

D. Variations in Cross-Sectional Dimensions:

1. For columns and thickness of walls from dimensions indicated, do not exceed:
   a. Plus 1/2 inch (12.7 mm), or minus 1/4 inch (6.4 mm).

3.5 ADJUSTING

A. Repair of damaged stone is permitted as some chipping of the stone is expected; repair of small chips is not required if it does not detract from the overall appearance of the work, or impair effectiveness of mortar and sealant installation.

B. Criteria for acceptance of chips and repairs will be based on industry standards and practices, unless other criteria is mutually agreed upon, in writing, by limestone masonry supplier and the Architect.

C. Remove and replace stonework with the following description:

1. Stones are so damaged that repair is not possible, either structurally or aesthetically.
2. Joints are defective.
3. Stones and joints are not in compliance with established standards based on samples and field-constructed mock-ups as approved by the Architect.
4. Stonework is not in compliance with other specified requirements.

D. Replace defective stonework with materials in compliance with established standards and specified requirements and showing no evidence of replacement.

3.6 CLEANING AND PROTECTION

A. Clean limestone masonry using clean water and stiff fiber bristle brushes. Do not use wire brushes, acidic type cleaning agents, or other materials or methods that could damage stone.

B. Mechanical or pressure cleaning methods may be used if approved in writing by the Architect.

C. Protect limestone masonry when adjacent brick is being acid-washed.

D. Provide protection and maintain conditions, in a manner acceptable to fabricator and installer that ensures limestone masonry will be without damage or deterioration the Date of Substantial Completion.

END OF SECTION 04 43 11

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SECTION 05 12 00 – ROOF LADDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aluminum access ladders

1.3 REFERENCES

A. AA – Aluminum Association.

B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

D. OSHA 1910.27 – Fixed Ladders.

1.4 COORDINATION

A. Coordinate layout and installation of the wood slats ceiling systems with other work penetrating the ceiling including light fixtures, HVAC equipment, and fire suppression system components.

1.5 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product.

B. Shop Drawings:

1. Detail fabrication and erection of each ladder indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. Provide reaction loads for each hanger and bracket.

C. Qualification Data: Refer to Quality Assurance provisions for submittal requirements evidencing experience, certifications, and resources.

D. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors.

E. F. Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, represent actual product color.

F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

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

1. Record of successful in-service performance.
2. Sufficient production capacity to produce required units.
3. Professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.

B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.

C. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.9 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurement before fabrication.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, indicate established dimensions on shop drawing submittal and proceed with fabrication.

1.11 WARRANTY

A. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.

1. Defects in materials and workmanship.
2. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.
3. Within the warranty period, the manufacturer shall, at its option, repair, replace, or refund the purchase price of defective ladder.

B. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. Manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses, resulting from the use of ladder products.

1.12 EXTRA MATERIALS

A. Furnish touchup kit for each type and color of paint finish provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide product by the following:

1. Alaco Ladder Co. 888-310-7040, sales@alacoladder.com
2. Architect approved equal

2.2 ALACO FOLDING WALL LADDER

A. Basic Use

1. Model HP70 (460) ladders are designed for roof hatch access. Ladders for roof hatch access can be ordered with or without flush handrails. They are extendible, then can be folded away when not in use. These ladders are available standard with non-marking, solid rubber feet for secure floor contact when extended.

B. Construction and Materials

1. ALACO aluminum ladders and their components are fabricated from 6061-T6 aluminum alloy for added safety, strength and long-lasting durability, with no painting required.
2. Model HP70 (460) folding wall ladders feature 3" (76 mm) or 4" (102mm) wide flat steps with nonslip ridges, mounted on 12" (305 mm) centers. They are equipped with mounting bracket-slide assemblies for flat storage against the wall. Non-marking solid rubber feet extend 3/4" (19.1mm) from the rail ends for secure installation at a 70 degree angle. Optional flush handrails consist of 1-1/4" (32 mm) round serrated aluminum tubing with cast aluminum fittings.

C. Type: Folding Wall Ladders- Model HP70 (460)-70° Roof hatch access

D. Sizes: Height- Up to 17'-10" (5.44 m). Width- 20" (508 mm)

E. Finishes and Coatings: Mill Finish. Paint coating to be selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Coordinate anchorages. Furnish setting drawings, templates, and anchorage structural loads for fastener resistance.

B. Do not begin installation until supporting structure is complete and ladder installation will not interfere with supporting structure work.

C. If supporting structure is the responsibility of another installer, notify Architect of unsatisfactory supporting work before proceeding.

3.2 METHODS

A. Model HP70 (460) Folding Wall Aluminum Ladder Standard Assembly

B. Establish distance from the floor to the underside of the roof hatch cover, then locate the mounting bracket centerline 15" (381 mm) for ladders under 11' (3.4 m) or 18" (457 mm) for ladders 11' (3.4 m) and over below the underside of the roof hatch cover. Check clear floor space required in unfolded position, then install the ladder at 70 angular degrees.

C. Complete installation recommendations for all product models are available from the manufacturer.

3.3 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Work shall not begin until the space is fully enclosed and glazed and all wet work is completed and dried out to the satisfaction manufacturer.

C. Temperature shall be at least 65 degrees Fahrenheit during the installation and thereafter.

D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.4 INSTALLATION

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.

3.5 CLEANING AND PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 05 12 00

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SECTION 05 50 00 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Loose bearing and leveling plates.
2. Shelf angles.
3. Metal bollards.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
3. Division 05 Section "Roof Ladders"
4. Division 06 Section "Rough Carpentry" for metal framing anchors.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For professional engineer.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Remove sharp or rough areas on exposed traffic surfaces.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M and ASTM A 992 Dual Grade.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

C. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.

D. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

E. Slotted Channel Framing: Cold-formed metal channels with flange edges returned toward web and with 9/16-inch- (14.3-mm-) wide slotted holes in webs at 2 inches (51 mm) o.c.

1. Width of Channels: 1-5/8 inches (41 mm).
2. Depth of Channels: As indicated.
3. Metal and Thickness: 12, 14, and 16 gage, galvanized steel complying with ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating; 0.064-inch (1.6-mm) minimum nominal thickness.
4. Metal and Thickness: 12, 14, and 16 gage uncoated steel complying with ASTM A 570, Grade 33; 0.0677-inch (1.7-mm) minimum thickness.
5. Finish: Hot-dip galvanized after fabrication.

F. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

G. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

B. Aluminium Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.

2.4 FASTENERS

A. General: Provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

D. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Plain Washers: Round, carbon steel, ASME B18.22.1 (ASME B18.22M).

G. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1 (ASME B18.21.2M).

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

I. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.5 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.6 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.7 LOOSE STEEL LINTELS

A. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches (200 mm), unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Shop prime and paint all sides of loose steel lintels prior to installation in interior walls with rust inhibitor paint. Galvanize all lintels exposed to weather.

2.8 SHELF ANGLES

A. For walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe.

B. Galvanize shelf angles to be installed in exterior walls.

2.9 STEEL GUARD POST AND SLEEVE

A. Fabricate steel guard posts Schedule 40 steel pipe. Fill with concrete and form a dome at top of pipe.

1. Prime and paint with bituminous paint each bollard prior to installation of protective sleeve. Refer to the article on Finishes.

B. Provide bumper post sleeves complying with the following requirements:

1. Dome top low density polyethylene thermoplastic nominal thickness 0.250”.
2. Sleeve to shield pipe diameter: 4”
3. Sleeve height: 36".
4. Sleeve Color: Blue/Black (#G39-6256).
5. Manufacturers: Subject to compliance with requirements, provide the products from the following: Ideal Shield L.L.C.; (313 842 7290).

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

A. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long at 24 inches (600 mm) o.c., unless otherwise indicated.
3. Furnish inserts if units must be installed after concrete is placed.

B. Galvanize miscellaneous framing and supports where indicated.

2.11 MISCELLANEOUS STEEL TRIM

A. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c., unless otherwise indicated.

2.12 GROUT

A. Nonshrink Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRDC 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

B. Products: Subject to compliance with requirements, provide one of the following:

1. “Bonsal Construction Grout”; W.R. Bonsal Co.
2. “Diamond-Crete Grout”; Concrete Service Materials Co.
3. “Euco N-S Grout”; Euclid Chemical Co.
4. “Kemset”; Chem-Masters Corp.
5. “Crystex”; L & M Construction Chemicals, Inc.
6. “Masterflow 713”; Master Builders.
7. “Sealtight 588 Grout”; W.R. Meadows, Inc.
8. “Sonogrout”; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.
9. “Stonecrete NM1”; Stonhard, Inc.
10. “Five Star Grout”; U.S. Grout Corp.
11. “Vibropruf #11”; Lambert Corp.

2.13 FINISHES, GENERAL

A. Comply with NAAHM “Metal Finishes Manual” for recommendations relative to application and designations of finishes.

B. Finish metal fabrications after assembly.

C. Galvanizing: For those items indicated for galvanizing, apply zinc-coating by the hot-dip process compliance with the following requirements:

1. ASTM A 153 for galvanizing iron and steel hardware.
2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick and heavier.

D. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP6 “Commercial Blast Cleaning”.
2. Interiors (SSPC Zone 1A): SSPC-SP3 “Power Tool Cleaning”.

E. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, masonry or sprayed on fireproofing, unless otherwise indicated. Comply with requirements of SSPC-PA1 “Paint Application Specification No.1” for shop painting.

2.14 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

2.15 FINISHES

A. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.

C. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.16 PAINT

A. Shop Primer for Ferrous Metal:

1. Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat.
   a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      1) Carboline 621; Carboline Company.
      2) Aquapon Zinc-Rich Primer 97-670; PPG Industries, Inc.
      3) Tneme-Zinc 90-97; Tnemec Company, Inc.

B. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint-20.

C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.17 METAL BOLLARDS, PIPE GUARDS, AND POSTS AT DUMPSTER ENCLOSURE

A. Bollards, pipe guards, and posts shall be fabricated of Schedule 40 steel pipe hot-dip galvanized (G60).

B. Bollards shall be provided with covers as detailed on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

D. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING METAL BOLLARDS

A. Installation of these items shall be detailed on working drawings.

B. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

END OF SECTION 05 50 00

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SECTION 05 73 00 – ALUMINUM RAILING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ornamental Aluminum Railing.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete: Placement of sleeves cast in concrete.

B. Section 05 50 00 - Metal Fabrications: Furnishing of sleeves cast in concrete.

C. Section 06 10 00 – Rough Carpentry: Placement of blocking in wall construction.

1.3 REFERENCES

A. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, Wire.

B. ASTM B 247 - Standard Specification for Aluminum and Aluminum Die Forgings, Hand Forgings and rolled Ring Forgings.

C. ASTM B 429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

D. ASTM E 935 - Standard Test Methods for Permanent Metal Railing Systems and Rails for Buildings.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Comply with requirements of building authorities having jurisdiction in Project location.

B. Structural Performance: Engineer, fabricate, and install, guardrails, and railing systems to withstand, when tested per ASTM E 935, loadings required by applicable building and safety codes but not less than the following:

1. Design Loads: Design to the following requirements. Concentrated and uniform loading need not be applied simultaneously.
2. Uniform load: 50 pounds per foot (74.3 kg/m) applied at the top in any direction.
3. Concentrated load: 200 pounds (90.6 kg) applied at the top in any direction.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 3000 – Administrative Requirements, for submittal procedures

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Details of material and construction.
3. Storage and handling requirements and recommendations.
4. Installation methods and requirements.

C. Shop Drawings: Submit shop drawings for fabrication and installation of ornamental metalwork. Include plans, elevations and detail sections. Indicate materials, methods, finishes and types of joinery, fasteners, anchorages and accessory items.

D. Load Tests: Submit test results from ASTM E 935 conducted on the manufacturer's supplied system indicating compliance with required structural loading.

E. Selection Samples: For each finish product specified, two complete sets of color charts representing manufacturer's full range of available colors and patterns.

F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 1-year documented experience producing systems specified in this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened, properly labeled, original packaging until ready for installation.

B. Store components to avoid damage from moisture, abrasion, and other construction activities.

C. Keep handling to a minimum. Exercise caution to avoid damage to factory applied finishes.

1.8 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Field Measurements: Take measurements of actual dimensions where necessary for fit without gaps. Indicate measurements on shop drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Match existing fencing

1. Acceptable Manufacturer: Superior Aluminum Products, Inc.; 555 E. Main St., P. O. Box 430, Russia, OH 45363. Phone: 937-526-4065. Fax: 937-526-3904. Email: info@superioraluminum.com. Web: www.superioraluminum.com.
   a. Product: Series 7P Aluminum Picket Fence

2. Architect approved equal: Requests for substitutions will be considered in accordance with provisions of Section 016000.

2.2 ORNAMENTAL ALUMINUM RAILINGS

A. Series 7P Aluminum Picket Fence

1. Design type: K, 4 1/2” spacing
2. Height: As indicated on the Drawings

2.3 GATES

A. Provide swinging gates of type and size indicated on the Drawings. Equip gates with manufacturer’s standard as required for complete functional operation.

1. Construction:
   a. Frame: Welded frame fabricated from post, top rail and bottom rail material.
   b. Infill: Match the railing design and configuration.
2. Size: As shown on the drawings

B. Hardware:

1. Hinges: Size and type as determined by manufacturer.
   a. Minimum of two hinges per leaf
2. Latch

2.4 MATERIALS

A. Rail, Post and Pickets: Aluminum extrusions; alloy and temper 6063-T4 or 6063-T6 or 6005A-T61 for rail and posts, and 6063-T5 for rectangular pickets.

1. Tube: ASTM B 211.

B. Base Flanges, Anchors, and railing accessories: ASTM B 247.

1. Bases cast from manufacturer's standard A-356-T6, 535, or 713 aluminum alloys or solid extruded 6063 aluminum alloy stock.
2. Base flanges and railing accessories cast from manufacturer's standard 319, A-356, A-356-T6, 535, or 713 aluminum alloys.
3. Anchorages: Provide concrete anchorage for fastening and complying with applicable Federal standards. All fasteners used in the system shall be aluminum or stainless steel.

C. Fasteners: Provide concrete anchorage for fastening and complying with applicable Federal standards. All fasteners used in the system shall be aluminum or stainless steel.

D. Grout: Non-shrink Portland cement-based hydraulic grout, mixed and applied in accordance with manufacturer's instructions; gypsum-based material is not acceptable. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and recommended by manufacturer for exterior use.

2.5 FINISH

A. Standard Architectural Coating (AAMA 2603): Color: TBD by Architect

2.6 FABRICATION

A. Tolerances: Verify dimensions on site prior to shop fabrication for proper connection to building structure or substrate.

B. Components or railing sections shall be fabricated to exact measurements specified through Drawings and field dimensions.

C. Railing sections shall be fabricated at the manufacturing facility in largest practical site delivery.

D. Railings angled horizontally, machine castings to proper angle.

E. Posts grouted in concrete to have one nominal 1/4 inch (6.0 mm) nominal diameter weep hole, 1/2 inch (12.0 mm) nominal above post collar, in the plane of the rail

F. Provide components required for anchorage of framing. Fabricate anchors and related components of material and finish as required, or as specifically noted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared. Fully review the supporting structure and substrate to verify a structurally sound base for anchoring railing system.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Coordinate railing installation with installation of waterproof membrane or coating Specified in Section 07 62 00 – Sheet Metal Flashing and Trim.

C. Ensure that adjacent surfaces, structures, and finishes are protected from damage by construction activities of this section.

D. Use wood blocks and padding to prevent damage to railing members and fittings during erection.

E. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Keep perimeter lines straight, plumb, and level.

C. Provide grounds, clips, backing materials, adhesives, brackets, anchors, and accessories necessary for a complete installation.

D. Expansion Bolt Mounting: Anchor through base plates to concrete substrate.

E. Sleeve Mounting:

1. Arrange for casting of sleeves or core drill concrete to provide holes for railing uprights.
2. After setting, fill holes with hydraulic grout; brace members until grout is cured.

F. Connect railing components in accordance with manufacturer’s instructions applicable to the specified system.

G. Tighten all fasteners so that completed railing is rigid and free of play at joints and component attachments.

H. Gates:

1. Install gates and adjust hardware for smooth operation.

2. After installation, test gate. Open and close a minimum of five times. Correct any deficiencies and adjust.

3.4 ERECTION TOLERANCES

A. Install plumb and level, securely fastened, with vertical members plumb.

1. Maximum variation from plumb: 1/4 inch (6.0 mm).
2. Maximum misalignment from true position: 1/4 inch (6.0 mm).
3. Maximum misalignment between adjacent separated members: 1/8 inch (3.0 mm).

3.5 CLEANING

A. Remove dust or other foreign matter from component surfaces; clean finishes in accordance with AAMA 609 and AAMA 610-02.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 05 73 00

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SECTION 07 41 13 – STANDING SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standing-seam metal roof panels.

B. Related Sections:

1. Section 053100 "Steel Decking"
2. Section 054000 "Cold-Formed Metal Framing"
3. Section 061600 "Sheathing"
4. Section 072100 "Thermal Insulation"
5. Section 076200 "Sheet Metal Flashing and Trim"
6. Section 079200 "Joint Sealants"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have in place a documented, standardized quality control program such as ISO-9001 approval.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels in manufacturer's original, unopened, undamaged containers with identification labels intact for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.6 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

A. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings .
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:

1. Test-Pressure Difference: Pressure of 20 Psf for 15 minutes .

C. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

2.2 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced, a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Garland Company, Inc. (The).
      1) R-Mer Loc Metal Roofing
   b. Firestone Building Products
      1) UC-6
      2) UC-11
   c. Architect approved equal

2.3 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.4 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
   a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
   b. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves, or projections, and properly sloped.
   c. Verify deck is dry and joints are solidly supported and fastened.
   d. Verify wood nailers are installed and correctly located. Do not use pressure-treated wood containing salt-based preservatives or materials corrosive to steel.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

A. Install metal panels in conformance with the NRCA Roofing and Waterproofing Manual and manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings . Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
9. Install underlayment and eave protection sheet underlayment as recommended by the Manufacturer.
10. Coordinate with installation of rigid board insulation as specified in Section 072100.
11. Install all panels continuous from ridge to eave. Transverse seams are not permitted.
12. Where not otherwise indicated conform to SMACNA details including flashings and trim.
13. Install sealants where indicated to clean dry surfaces only without skips or voids.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.

4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13

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SECTION 07 54 23 – THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES
- A. Fleece Back KEE adhered membrane over steel deck (EXISTING).

1.2 RELATED SECTIONS
- A. Section 06 10 00 - Rough Carpentry.
- B. Section 07 62 00 - Sheet Metal Flashing and Trim.

1.3 REFERENCES
- A. American Society of Civil Engineers (ASCE) 7 Minimum Design of Loads for Buildings and Other Structures.
- B. American Society for Testing and Materials (ASTM) C 208 - Standard Specification for Cellulosic Fiber Insulating Board.
- C. American Society for Testing and Materials (ASTM) C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- D. American Society for Testing and Materials (ASTM) D 41 - Standard Specification for Asphalt Used in Roofing.
- E. American Society for Testing and Materials (ASTM) D 312 - Standard Specification for Asphalt Used in Roofing.
- F. American Society for Testing and Materials (ASTM) D 1079 - Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Material.
- G. American Society for Testing and Materials (ASTM) D 4263 - Standard Test Method for Indicating Moisture in Concrete.
- H. American Society for Testing and Materials (ASTM) D 4434 - Standard Specification for Poly (vinyl chloride) Sheet Roofing.
- I. American Society for Testing and Materials (ASTM) D 6506 - Standard Specification for Asphalt Protection Board.
- J. American Society for Testing and Materials (ASTM) E 408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
- K. American Society for Testing and Materials (ASTM) E 903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
- L. American Society for Testing and Materials (ASTM) E 1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- M. Factory Mutual (FM Global) - Approval Guide.

N. Factory Mutual Standard 4470 - Approval Standard for Class 1 Roof Covers.

O. National Roofing Contractors Association (NRCA).

P. Sheet Metal and Air Conditioning Contactors National Association, Inc. (SMACNA) Architectural Sheet.

Q. Underwriters Laboratories (UL) - Roofing Systems and Materials Guide (TGFU R1306).

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Compliance with ASTM D6754-02

C. Shop Drawings:
1. Show location and type of penetrations, perimeter and penetration flashing detail references to manufacture's standard. Details which do not conform to roofing manufacturer's standards shall be identified with separate approval from roofing manufacturer. Details to be employed on the project shall be approved by roofing manufacturer.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

F. Letter from Manufacturer stating they have been in business and has not filed for bankruptcy in the past 15 years. Also, that they will inspect the job 3 days a week during installation by a full time employee of the manufacturer with no less than 5 years' experience.

G. Letter from Installer stating they have been in business no less than 5 years and have not filed for bankruptcy during that time. Also, outlining they have been an authorized installer of the material manufacturer no less than 5 years and in good standing for all systems they will be installing.

H. Manufacturer must provide no less than 5 jobs of similar scope within a 60 mile radius available for inspection.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Membrane manufacturer shall have a minimum of fifteen (15) years experience in the production of thermoplastic scrim-reinforced membrane and related accessories.
2. Membrane manufacturer shall be listed in UL and have FM Approvals for membrane roofing systems for a minimum of 15 years.
3. The roofing membrane manufacturer is defined as a company which makes the

primary roofing membrane and flashing membrane in its own factories from rawer states of material. No “Private Label” material, in which one company’s name goes on a product manufactured by others, is acceptable.

B. Installer Qualifications:
   1. Installer shall have a minimum of five (5) years experience in the application of thermoplastic membrane and shall be certified by the manufacturer of the membrane system.
   2. Prior Installer: Enterprise Roofing (1021 Irving Ave, Dayton, OH 45419)

C. Product Requirements:
   1. LEED (USGBC) Certification: The roof system shall comply with LEED requirements for the use of a high albedo roofing material with a Solar Reflectance Index (SRI) of no less than 78 when calculated in accordance with ASTM E 1980. Compliance based on a reflectance rating of at least 0.80 when tested according to ASTM E 903 and an emissivity rating of at least 0.9 when tested in accordance with ASTM E 408 for a minimum of at least 75 percent of the roof surface.
   2. Membrane Qualifications: Membrane shall be factory certified, first run material, seconds will not be permitted. Approvals:
      a. State of Florida Building Code Product Approval.
      b. Miami/Dade County Florida NOA.
      c. UL Evaluation Report.
      d. HUD.
      e. Energy Star Partner.
      f. Material and packaging to bear the FM label.
   3. The roofing systems shall meet the Factory Mutual 1-105 requirements.
   4. The roofing systems shall meet the Underwriters Laboratories Class A requirements.

D. Pre-Installation Conference:
   1. Prior to scheduled commencement of the roofing installation and associated work conduct a meeting at the project site with the Installer, Architect, Building Owner, Manufacturer's Representative and any other entities directly involved with the performance of the work.
   2. The installer shall record conference discussions to include decisions, agreements, and open issues and furnish copies of recorded discussions to each attending party. The primary purpose of the meeting is to review foreseeable methods and procedures related to roofing work schedule and quality.

E. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

F. Manufacturer shall provide 3 day a week job inspections during the installation accompanying report with written and photographic evidence of all visits outlining the acceptance, corrective action, conditions and progress of the project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect stored materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer. Leave product wrapped and protected in original packaging with identification labels, until ready for use on the job.

C. Store in a clean, dry, well ventilated area protected from weather and other trades. All rolls of membrane shall be stored, lying down, elevated above the roof deck and completely protected from moisture with tarpaulins.

D. Insulation shall be stored on pallets, fully protected from moisture with tarpaulins. Adhesives shall be safely stored, at temperatures above 45 degrees F (7 degrees C). Flammable materials shall be stored in a cool dry area away from sparks and open flames.

E. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Weather:
   1. Proceed with the roof installation only when existing and forecasted weather conditions permit.
   2. Ambient Temperatures shall be above 45 degrees F (7 degrees C) when applying hot steep asphalt, water based adhesives or urethane adhesives.

1.8 WARRANTY

A. Manufacturer warrants to the Building Owner, subject to the terms, limitations, and conditions for a period specified, in which the Materials and Workmanship Warranty is effective, the materials installed shall be free from defects in materials supplied and/or defective workmanship provided by the authorized applicator.
   1. The Manufacturer's Technical Service Representative shall inspect the completed roof system, and upon acceptance, the manufacturer shall issue the specified warranty commencing on the Date of Substantial Completion.
   2. The Roofing System shall receive the manufacturer's standard twenty (20) year guarantee of water tightness.
   3. Installing contractor to provide a 2-year labor and materials warranty

B. Sheet Metal Warranty: Materials supplied by the roofing manufacturer.
   1. Materials shall be free of defects in material and workmanship for thirty years after shipment. Defective materials will be repaired or replaced at manufacturer's option. Manufacturer shall not be liable for direct or consequential damages arising from the installation of materials. No other express or implied warranties apply to the products.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Viking Products Group, which is located at: 3812 East 91st Street; Cleveland, OH. 44105

B. Requests for substitutions will be considered in accordance with the provisions of Section 01 60 00.

2.2 SYSTEM

A. FB KEE must meet ASTM D6754-02.
   1. Color: White.
   2. Roof System: Provide and install an Adhered, Fleece-Back, Thermoplastic, CRRC approved roofing membrane to a protected insulation system attached to a structural concrete or metal deck.
   3. Approved Vendors:
      a. The Garland Company (Todd Poeppelmeier, 937-239-4316, toddp@garlandind.com)

2.3 MEMBRANE

A. Membrane: The roofing membrane shall meet or exceed the requirements of ASTM D6754-02 standard for membrane sheet roofing.

B. ASTM D6754-02 Fleece Back KEE Membrane:
   1. FB 80 mil KEE Fleece Back.
   3. FB 60 mil KEE Fleece Back

2.4 INSULATION

A. Refer to Insulation Specification Section 072200

2.5 ACCESSORY MATERIALS

A. Adhesives:
   1. Substrate Adhesive: as supplied by roofing material manufacturer for adhering fleece back membrane to approved substrates.
   2. Flashing Adhesive: as supplied by roofing materials manufacturer for laminating flashing to vertical surfaces.
   3. KEE Lock HR Insulation Adhesive: For adhering insulation or cover boards to approved substrates.
   4. FB Foam Adhesive- two part urethane foam adhesive for fleece back membranes.

B. Fasteners:
   1. Metal Decks: screw type fasteners treated for corrosion resistance with ultimate pull out value of minimum 420 lb (189 kg) in 22 (0.759 mm) gauge steel deck to be applied in conjunction with Factory Mutual approved pattern:
      a. SFS Intec, Dekfast Fastening System, C-2 type, corrosion resistant only.
      b. OMG Inc., Fasteners, screws long and short, Endurion coated only.
   2. Plywood Decks: screw type fasteners applied in a Factory Mutual approved pattern and method.
      a. SFS Intec Inc., Dekfast Fastening System, C-2 type, corrosion resistant only.
      b. OMG Inc. Fasteners, screws long and short, Endurion coated only.
   3. Solid Wood Decks: screw or nail type fasteners:

a. SFS Intec, Dekfast Fastening System, C-2 type, corrosion resistant only.
b. OMG Inc., Fasteners, screws long and short, Endurion coated only.

4. Masonry Decks: solid limestone concrete block minimum pullout resistance shall be 525 lb (236 kg), expanded slag block minimum pullout resistance shall be 1100 lb (495 kg), poured concrete, minimum pullout resistance shall be 1000 lb (450 kg):
   a. SFS Intec. Dekspike Concrete Roofing Anchor
   b. OMG Inc., Fluted Nail or Olympic CD-10
5. Through Lightweight Concrete or Gypsum Fill:
   a. On steel deck see 3A above.
   b. On foamboard: toggle bolts or,
   c. OMG, Inc. GypTec or Lite Deck Fastener.
   d. SFS Intec, Dek Lite Fastener

C. Sealants:
1. Caulking: approved by materials manufacturer
2. For filling pitch pans: Pourable Sealer or as approved by roofing materials manufacturer.

D. Flashing:
1. Reinforced Membrane: KEE, same material, color and thickness as roof membrane for all curbs, walls and penetrations.
2. Non reinforced Detail Membrane: multi angled intersections, sealant pockets and other conditions that would be impractical for reinforced membrane application.

E. Base Sheet:
1. Base sheets or ply sheets installed over substrate or insulation system as an integrated component of Flex built up roofing system.
   a. SBS 80 mil S/S Base Sheet.
   b. Premium Ply Roofing Felt.

F. Wood Nailers:
1. Number 2 grade lumber minimum salt treated for rot and fire resistance.
   a. Wolmanized.
   b. Osmose treated.
   c. Pressure treated.

G. Separation Layers:
1. Georgia Pacific Corporation: Dens Deck, Dens Deck Prime distributed by Viking Products Group.
2. USG Securock Roof Cover Board distributed by Viking Products Group.
3. VPG-HD ½” Coverboard, High Strength Polyisocyanurate Foam with coated Glass Facers distributed by Viking Products Group.

H. Edge Termination:
1. Size and profile as indicated on drawings.
2. Profiles and designs engineered for roof perimeter attachment. Components from the membrane manufacturer shall be approved for FM 1-90 rating and ANSI/SPRI ES-1-2012 Wind Design Standard for Edge Systems according to sheet metal specification section 076200

3. Finish: TBD by owner out of standard roofing manufacturer color options and provide 30 year warranty
4. KEE Clad Metal: for custom fabrication of a hot air weldable edge metal.

I. Detailing Components:
1. KEE Preformed Inside and Outside corners.
2. KEE Preformed Pipe Boots.
3. KEE Split Pipe Boots.
4. Retrofit Drains.
5. KEE Walkway Pad: Traffic Pads: 30 inches (762 mm) wide by 60 feet (18 m) long by 0.80 inch (2 mm) thick thermoplastic material provided by the membrane manufacturer.
6. 2-3/8 inches (60 mm) XHD Barbed Plate.
7. 2-3/4 inches (70 mm) SXHD Barbed Plate.
8. Base Sheet Fastener.
9. Termination Bar.
10. Standard Screws.
11. HD Standard Screws.
12. XHD Standard Screws.
13. SXHD Standard Screws.

2.6 VAPOR RETARDERS

A. Torch base sheet: 90 mil (2.2 mm) SBS polyester reinforced membrane with sanded upper surface to receive mopping or cold applied adhesives for insulation or cover boards. Plus a thermofusable lower surface for torch applied installation to approved substrates.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION
A. Clean surfaces thoroughly prior to installation.

B. Prepare deck surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
1. Decking shall be G-90 galvanized coated 22 gauge (0.759 mm) or heavier steel panel.
2. Decking shall be installed to provide positive slope and positive drainage.
3. Deck panels shall be securely anchored to the supporting members in accordance with the Steel Deck Institutes Design Manual and Factory Mutual Recommendations.
4. Deck panels shall be installed in a straight line and properly aligned.
5. Deck shall be clean and free of moisture or debris.

3.3 INSTALLATION
A. Install roof system in accordance with manufacturer's instructions.

B. Wood Nailers:
   1. Locate and install along gravel stops and drip edges and other areas as required by membrane manufacturer.
   2. Anchor nailer to structural deck with manufacturers approved fasteners, spaced appropriately for the specified installation; minimum withdrawal resistance 100 pounds (45 kg) per fastener.

(Optional) Install Vapor Retarder

C. Insulation:
   1. Insulation shall be mechanically attached to the steel decking with manufacturer's recommend fastener and plate.
   2. Insulation board size as recommended by manufacturer for adhered application.
   3. Insulation shall be fastened to the steel decking in accordance with FM 1-29 Data Sheet recommendations.
   4. Do not install wet, damaged or warped insulation boards.
   5. Install insulation boards with staggered board joints in one direction.
   6. Insulation boards to be installed so that no gaps larger than 1/4 inch (6 mm) are found at the end joints and that the adjoining top surfaces are flat and smooth. All gaps in excess of 1/4 inch (6 mm) shall be filled with like insulation material.
   7. If more than one layer of insulation board is to be installed the joints of the subsequent layers must be staggered. Stagger the joints in the additional layers a minimum of 6 inches (152 mm) from the underlying insulation boards to eliminate vertical gaps.
   8. Do not install any more insulation than will be completely waterproofed each day.
   9. Provide separation layer as required by manufacturer.

F. Membrane Installation:
   1. Fully adhere membrane to acceptable substrate with hot steep asphalt or KEE Cold Adhesive applied at the rate specified by the manufacturer.
   2. Position sheets as indicated on approved shop drawings. Measure and chalk lines on the substrate to establish proper alignment of the sheet.
   3. Place the roll on the line and unroll the Solar Brite FB its entire length and allow the membrane to relax. The relaxation time required is dependent on the ambient air temperature.
   4. Fold one end of the Solar Brite FB sheet on top of itself until both ends meet. Apply the bonding material (KEE Cold Adhesive) to the prepared roof surface. The sheet can then be pulled and laid into the bonding material using care not to create any wrinkles.
   5. Carefully push and broom into place from fold line to overlap, avoiding wrinkles and air pockets. Roll with a heavy roller (minimum 200 lb (90 kg)) to insure proper adhesion.
   6. Repeat procedure for other half of sheet.
   7. Lap seams shall be done by lapping the 3 inches (76 mm) selvedge edge over the non selvedge edge of the previous roll. Do not allow adhesives or other contaminants into the lapped seam. The selvedge edge seam will be completed by the hot air welding method. Seams are to be completed each day during construction.

8. Roll ends are butted together and capped with an 8 inches (203 mm) wide Stripping roll. The Stipping roll is centered over the end joint and hot air welded into place.
9. All seams shall be checked with a needle probe and any voids repaired with the heat gun the same day they are made.
10. Seams greater than 10 feet (3 m) in length shall be welded with the automatic type welding unit. Hand held welders shall be used only for the remaining seams and detail welding.

G. Flashing:
1. Flash penetrations, walls, curbs, expansion joints, drains as shown on details with KEE flashing membrane.
2. Use prefabricated sealant pockets and pre-molded vent / pipe flashing.
3. Mechanically fasten flashing at terminations according to approved details. Fastening flashing membrane through counter-flashing metal is not acceptable.
4. Flashing membranes shall be adhered to the approved substrate with KEE Flashing Adhesive. Flashing Membrane is to be installed flat and wrinkle free. Flashings shall be rubbed or rolled onto the substrate for proper adhesion.

3.4 INSPECTION
A. Seam Inspection:
1. All seams are to be completed by the hot air welding method each day as the installation progresses.
2. The roofing contractor is to designate a responsible person experienced in hot air welding techniques to inspect the completed installation each day as the installation progresses. The inspection is to include hand probing of all welded seams.
3. Any defects found during these inspections should be immediately corrected.

B. Manufacturer's Field Services:
1. Provide manufacturer's field service consisting of product use recommendations and no less than 3 day a week job inspections providing a written and photographic report of each visit outlining the progress, acceptance, corrective action, conditions with photographic evidence and written summary by material manufacturer with no less than 5 years' experience and be a current employee material manufacturer.
2. Site Visits: Final inspection and acceptance of the installation by the manufacturer's technical representative is required before a warranty can be issued.

3.5 PROTECTION
A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 07 54 23

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SECTION 08 09 11 - GLAZED ALUMINUM CURTAIN WALL

PART 1 – GENERAL

1.01 SUMMARY

A. Related Documents: Conditions of the Contract, Division 1 - General Requirements, and Drawings apply to Work of this Section.

B. Section Includes:
1. Aluminum curtain wall systems, complete with reinforcing, shims, anchors, and attachment devices.
2. Accessories necessary to complete Work.

C. Products Furnished But Not Installed Under this Section: Inserts and anchoring devices that are to be built into structure.

D. Related Sections:
1. Section 01411 - Exterior Curtain Wall Testing.
2. Section 01430 - Mock-Ups.
3. Section 05500 - Metal Fabrications.
4. Section 06100 - Rough Carpentry.
5. Section 07211 - Batt and Blanket Insulation.
6. Section 07270 - Firestopping.
7. Section 07900 - Joint Sealers.
8. Section 0841X - Aluminum Entrances and Storefronts.
9. Section 08450 - All Glass Entrances.
10. Section 08470 - Revolving Entrance Doors.
11. Section 08490 - Sliding Mall Fronts.
12. Section 08520 - Aluminum Windows.
13. Section 08710 - Door Hardware.
14. Section 08810 - Glass and Glazing.
15. Section 08960 - Sloped Glazing System.
16. Section 12511 - Horizontal Louver Blinds.

1.02 REFERENCES

A. Aluminum Association (AA):
1. DAF-45 Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association (AAMA):
1. CW-DG-1 Aluminum Curtain Wall Design Guide Manual.
2. 501.2 Field Check of Metal Curtain Walls for Water Leakage.
3. 2605 Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
4. 611 Voluntary Specification for Anodized Architectural Aluminum

C. American National Standards Institute (ANSI):
1. Z97.1 Specifications and Methods of Test for Safety Glazing Material Used in Buildings.

D. American Society for Testing and Materials (ASTM):

1. A36 Structural Steel.
2. A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. A525 General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
4. A526 Sheet Steel, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
5. B209 Aluminum and Aluminum-Alloy Sheet and Plate.
6. B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
7. B308 Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded.
8. C716 Installing Lock-Strip Gaskets and Infill Glazing Materials.
9. C920 Elastomeric Joint Sealants.
10. E283 Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
11. E330 Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
12. E331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
13. E773 Test Method for Seal Durability of Sealed Insulating Glass Units.
14. E774 Sealed Insulating Glass Units.

E. Consumer Product Safety Commission (CPSC):
1. 16 CFR 1201 Safety Standard for Architectural Glazing Materials.

F. Federal Specifications (FS):
1. TT-P-645A Primer, Paint, Zinc Chromate, Alkyd Type.

G. Glass Association of North America (GANA):
1. Glazing Manual.

H. Steel Structures Painting Council (SSPC):
1. SP2 Hand Tool Cleaning.
2. SP3 Power Tool Cleaning.
3. Paint 12 Cold-Applied Asphalt Mastic (Extra Thick Film).

1.03 SYSTEM REQUIREMENTS

A. General Standard: In addition to requirements shown or specified, comply with applicable provisions of Aluminum Curtain Wall Design Guide Manual for design, materials, fabrication and installation of component parts.

B. Design Requirements:

1. Metal stick framed systems with interior and exterior exposed metal framing.
2. Operable vent with sight line concealed from the exterior. Perimeter members to be integral with window wall framing.]
3. System manufacturer shall provide low profile entrance frames as an integral part of the curtain wall system.]
4. System manufacturer shall provide curtainwall systems, including necessary modifications to meet specified requirements and maintaining visual design concepts.
5. Fabricate glazing systems for exterior glazing at vision areas and exterior glazing at spandrel areas.
6. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer's recommended joint design.
7. Drawings are diagrammatic and do not purport to identify nor solve problems of thermal or structural movement, glazing, anchorage or moisture disposal.

8. Requirements shown by details are intended to establish basic dimension of unit, sight lines and profiles of members.
9. Do not assume glass, sealants, and interior finishes contribute to framing member strength, stiffness, or lateral stability.
10. Attachment considerations are to take into account site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening or fracturing connection between units and building structure or between units themselves.
11. Allow for expansion and contraction due to structural movement without detriment to appearance or performance.
12. System shall drain to exterior face of wall, water entering joints and condensation occurring within system by drain holes and gutters of adequate size to evacuate water without infiltration to interior or the top of lower lites of glass.
13. Provide concealed fastening.
14. Metal faces are required to be visually flat under all lighting conditions, subject to acceptance of Architect.
15. Use dense EPDM isolators to maintain adequate compression on glazing material.
16. Provide uniform color and profile appearance at components exposed to view.
17. Provide interior dense EPDM [closed cell EPDM sponge] gasket with sealed corners, with maximum 30% compression when glazed, to create a water and air seal. Provide exterior dense EPDM wedge gasket at the verticals and exterior EPDM gasket at the horizontals, with a maximum 30% compression when glazed, to create a water & air seal.
18. Provide pre-punched pressure plates to ensure correct quantity and spacing of fasteners.

C. Performance Requirements:
1. Air infiltration: Air leakage shall not exceed 0.06 cfm per square foot of surface area when tested in accordance with ASTM E283 at differential static pressure of 6.24 psf.
E. 2. Water Resistance (static): No uncontrolled leakage when tested in accordance with ASTM E331 at test pressure of 15.0 psf as defined in AAMA 501.
F. 3. Water Resistance (dynamic): No uncontrolled leakage when tested in accordance with ASTM E331 at test pressure of 15.0 psf as defined in AAMA 501.
G. 4. Uniform Load: A static air design load of 40 psf shall be applied in a positive and negative direction in accordance with ASTM E 330. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

D. Structural Requirements:
1. Wind loading:
E. a. Basic zones:
b. Corner zones:
[c. Parapet zones:]
2. Deflection under uniform loading: When tested in accordance with ASTM E330 at design pressure, maximum deflection of exterior member shall not exceed L/175 for spans up to 13’-6” or L/240 + 1/4” for spans greater than 13’-6”.
3. Parallel to wall and corner mullion deflections: 75% of glass edge bite or 3/8 inch, whichever is less.
4. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from:
a. Anchors to building structure and
b. Horizontal glazing rails or interior trim, which are in actual contact with

compression flange.

5. Do not regard points of contra-flexture as lateral braces or as end points of un-braced length; un-braced length is actual distance between effective lateral braces as defined above.
6. Where framing member reaction is resisted by continuous element, maximum assumed effective length of the resisting element is 4 times bearing length, but not more than 12 inches.

E. E. Thermal Requirements: Framing systems shall accommodate expansion and contraction movement due to surface temperature differential of 180F without causing buckling, stress on glass, failure of joint seals, excessive stress on structural elements, reduction of performance or other detrimental effects.

F. F. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-Factor) shall not be more than .63 (with clear glass).

G. G. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 66 (for the frame).

H. H. Seismic: When tested to AAMA 501.4, system must meet design displacement of 0.010 x the story height and ultimate displacement of 1.5 x the design displacement, 0.015 x the story height, and 0.025 x the story height.

I. I. Sound Transmission: When tested to ASTM E90, the Sound Transmission Class (STC) shall not be less than 33 based upon 1” insulating glass (1/4”, 1/2” AS, 1/4”); OR, not less than 37 based upon 1” insulating glass (1/4” Lam, 1/2” AS, 1/4” Lam).

[J. Laboratory Testing: Refer to Section 01411 for requirements.]

K. Interface:

1. Furnish inserts and anchoring devices, which need to be preset and built into structure to appropriate trade.
2. Supply on timely basis to avoid delay in Work.
3. Instruct other trades of proper location and position.
4. Furnish setting drawings, diagrams, templates and installation instructions.

1.04 SUBMITTALS

A. General: Submit in accordance with Section 01300.

B. Product Data:

1. Submit manufacturer's descriptive literature for each manufactured products.
2. Include information for factory finishes, accessories and other required components.

3. Include color charts for finish indicating manufacturer's standard colors available for selection.

C. Shop Drawings:

1. Submit drawings indicating elevations, detailed design, dimensions, member profiles, joint locations, arrangement of units, member connections, and thickness of various components.
2. Show following items:
   a. Details of special shapes.
   b. Reinforcing.
   c. Drainage details and flow diagrams.
   d. Anchorage system.
   e. Interfacing with building construction.
   f. Provisions for system expansion and contraction
   g. Thermal breaks

4. Indicate glazing details, methods, [locations of various types and thickness of glass] [, emergency breakout locations,] and internal sealant requirements.
5. Clearly indicate locations of exposed fasteners and joints for Architect's acceptance.
6. Clearly show where and how manufacturer's system deviates from Contract Drawings and these Specifications.

D. Mock-up Drawings: Submit drawings for mock-ups; refer to Section 01430 for mock-up requirements

E. Samples:
G. 1. Submit manufactures samples indicating quality of finish in required colors.
2. Where normal texture or color variations are expected, include additional samples illustrating range of variation.
3. Submit samples of sealants for color selection.

I. Manufacturer's Instructions: Submit manufacturer's printed installation instructions

J. Warranty: Submit specified warranties.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:
1. Provide curtainwall systems that are products of a single manufacturer.

B. Engineer Qualifications: Professional Structural Engineer registered in State where Project is located.
C. Installer Qualifications: Certified in writing by system manufacturer as qualified for specified systems.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Comply with requirements of Section 01600.
B. Protect finished surfaces to prevent damage.
C. Do not use adhesive papers or sprayed coatings, which become firmly bonded when exposed to sun.
D. Do not leave coating residue on surfaces.

1.08 PROJECT CONDITIONS
A. Ensure ambient and surface temperatures and joint conditions are suitable for installation of materials.

1.09 WARRANTY
A. Provide warranties in accordance with Section 01700.
B. Provide written warranty in form acceptable to Owner jointly signed by manufacturer, installer and Contractor warranting work to be watertight, free from deflective materials, defective workmanship, glass breakage due to defective design, and agreeing to replace components which fail within 1 year from date of Substantial Completion.
C. Warranty shall cover following:
1. Complete watertight and airtight system installation within specified tolerances.
2. Glass and glazing gaskets will not break or "pop" from frames due to design wind, expansion or contraction movement or structural loading.
3. Glazing sealants and gaskets will remain free from abnormal deterioration or dislocation due to sunlight, weather or oxidation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

A. Subject to compliance with requirements indicated, provide products by one of the following:
   1. **Oldcastle Building Envelope** (Deron Dile, 317-213-8549, ddile@obe.com) RELIANCE WALL - 1” Glazing: 2-1/2" x 7-1/4" mullion profiles; pressure glazed, front set, exterior glazed, stick wall system.
   2. Architect approved equal

2.02 FRAMING MATERIALS AND ACCESSORIES

A. Aluminum:
   1. ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 5005-H16 for sheets; or other alloys and temper recommended by manufacturer appropriate for specified finish.

B. Internal Reinforcing:
   1. ASTM A36 for carbon steel; or ASTM B308 for structural aluminum.
   2. Shapes and sizes to suit installation.
   3. Shop coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.

C. Inserts and Anchorage Devices:
   1. Manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars or tubes.
   2. Hot-dip galvanize steel assemblies after fabrication, comply with ASTM A123, 2.0 ounce minimum coating.

D. Fasteners:
   1. Non-magnetic stainless steel or cadmium plated steel coated with yellow or silver iridescence plating, compatible with materials being fastened.
   2. Series 300 stainless steel for exposed locations. Cadmium plated steel with 0.0005 inch plating thickness and color chromate coated for concealed locations.
   3. Provide nuts or washers of design having the means to prevent disengagement; deforming of fastener threads is not acceptable.
   4. Provide concealed fasteners wherever possible.
   5. For exposed locations, provide countersunk flathead fasteners with finish matching item fastened.

E. Expansion Anchor Devices: Lead-shield or toothed-steel, drilled-in, expansion bolt anchors.

F. Shims: Non-staining, non-ferrous, type as recommended by system manufacturer.

G. Protective Coatings: Cold applied asphalt mastic complying with SSPC-Paint 12, compounded for 30 mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645.

H. Glazing Gaskets:
   1. Compression type design, exterior replaceable, extruded EPDM. Interior is a dense EPDM [closed cell EPDM sponge] gasket.
   2. Comply with ASTM C509 or C864.
   3. Profile and hardness as necessary to maintain uniform pressure for watertight seal.
   4. Manufacturer's standard black color.

I. Internal Sealants: Types recommended by system manufacturer to remain permanently non-hardening, non-migrating and weather-tight.

2.03 GLASS AND GLAZING ACCESSORIES

A. Refer to Section 08810.

2.04 SYSTEM FABRICATION

A. Take accurate field measurements to verify required dimensions prior to fabrication.
B. Location of exposed joints is subject to Architect's acceptance.
C. Provide dense EPDM continuous isolator to separate exterior pressure plates and interior framing members.
D. Fabricate components in accord with approved shop drawings. Remove burrs and ease edges. Shop fabricate to greatest extent practicable to minimize field cutting, splicing, and assembly. Disassemble only to extent necessary for shipping and handling limitations.
E. Steel Components:
   1. Clean surfaces after fabrication and immediately prior to application of primer in accord with SSPC-SP2 or SSPC-SP3 at manufacturer's option.
   2. Apply specified shop coat primer in accord with manufacturer's instructions to provide 2.0 minimum dry film thickness.
F. Fabricate components true to detail and free from defects impairing appearance, strength or durability. [Fabricate custom extrusions indicated and as necessary for complete installation.]
G. Fabricate components to allow for accurate and rigid fit of joints and corners. Match components carefully ensuring continuity of line and design. Ensure joints and connections will be flush and weather-tight. Ensure slip joints make full, tight contact and are weather-tight.
H. Reinforce components as required at anchorage and support points, at joints, and at attachment points for interfacing work.
I. Provide structural reinforcing within framing members where required to maintain rigidity and accommodate design loads.
J. System design and sealants to accommodate internal weep and drainage system not visible to the exterior.
K. Head and sill extrusions act as gutter and weep water to exterior; do not penetrate sections with fasteners.
L. Allow for adequate clearance around perimeter of system to enable proper installation and for thermal movement within system.
M. Separate dissimilar metals with protective coating or preformed separators to prevent contact and corrosion.

2.05 FINISH

A. Organic Coating (high performance fluorocarbon):
   1. Comply with requirements of AAMA 2605.
   2. Surfaces cleaned and given conversion coating pre-treatment prior to application of 0.3 mil dry film thickness of epoxy or acrylic primer following recommendations of finish coat manufacturer.
   3. Color: Match existing

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions and proceed with Work in accordance with Section 01400.
B. Verify dimensions, tolerances, and method of attachment with other Work.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and applicable provisions of AAMA Aluminum Curtain Wall Design Guide Manual.

B. Align assemblies plumb and level, free of warp or twist, aligning with adjacent Work.
C. Tolerances:
   1. Limit variations from plumb and level:
      a. 1/8 inch in 20'-0" vertically and horizontally.
      b. 1/4 inch in 40'-0" either direction.
   2. Limit offsets in theoretical end-to-end and edge-to-edge alignment:
      a. 1/16 inch where surfaces are flush or less than 1/2 inch out of flush and separated by not more than 2 inches.
      b. 1/8 inch for surfaces separated by more than 2 inches.
   3. Step in face: 1/16 inch maximum.
   4. Jog in alignment: 1/16 inch maximum.
   5. Location: 1/4 inch maximum deviation of any member at any location.
   6. Tolerances are not accumulative.
D. Provide attachments and shims to permanently fasten system to building structure.
E. Anchor securely in place, allowing for required movement, including expansion and contraction.
F. Separate dissimilar materials at contract points, including metal in contact with masonry or concrete surfaces, with protective coating or preformed separators to prevent contact and electrolytic action.
1. G. Set sill members in bed of sealant. Set other members with internal sealants and baffles to provide weather-tight construction.
2. H. Water Drainage: Each light of glass shall be compartmentalized using joint plugs and silicone sealant to divert water to the horizontal weep locations. Weep holes shall be located in the horizontal pressure plates and covers to divert water to the exterior of the building.

J. Ensure that dead-load from curtain wall system is not transferred to stone veneer.
K. Glazing:
   A. 1. Install glazing gaskets and sealants in accordance with manufacturer's instructions without exception; including surface preparations. Refer to Section 08810 for additional requirements.
   B. 2. Outside glazed and held in place with extruded aluminum pressure plates anchored to the mullion using Drill-Flex fasteners spaced no greater than 9” on center.
L. Fire-Safing and Curtain Wall Insulation:
   1. Install fire safing and curtain wall insulation specified in Section 07200 and 07270.

3.04 CLEANING
A. Clean surfaces in compliance with manufacturer's recommendations; remove excess mastic, mastic smears, and other foreign materials.
B. Clean metal surfaces exercising care to avoid damage.

END OF SECTION 08 09 11

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SECTION 08 41 13 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.

B. Related Requirements:

1. Section 088000 “Glazing”

1.3 REFERENCES

A. ASTM E2112-07 Standard Practice for Installation of Exterior Windows, Doors and Skylights

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.
3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.5 INFORMATIONAL SUBMITTALS

1.6 QUALITY ASSURANCE

A. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

B. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems that include structural glazing.

1.7 WARRANTY

A. Special Warranty: **Manufacturer** agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures, including, but not limited to, excessive deflection.
   b. Noise or vibration created by wind and thermal and structural movements.
   c. Deterioration of metals**, metal finishes,** and other materials beyond normal weathering.
   d. Water penetration through fixed glazing and framing areas.
   e. Failure of operating components.
2. Warranty Period: **10** years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Delta E units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, peeling, or chipping.
2. Warranty Period: **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

B. Structural Loads:

1. Wind Loads: As indicated on Drawings.

C. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or **1/8 inch** , whichever is smaller
    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
    a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans of less than 11 feet 8-1/4 inches.

D. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at **150** percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence

material failures, structural distress, or permanent deformation of main framing members exceeding **0.2** percent of span.

3. Test Durations: As required by design wind velocity, but not less than **10** seconds.

E. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **10 lbf/sq. ft.**

F. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than **10 lbf/sq. ft.**
2. Maximum Water Leakage: [According to AAMA 501.1] [No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation]. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

G. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

H. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.3 STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kawneer North America.
2. Oldcastle BuildingEnvelope™.
3. CRL, A CRH Company

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken .
2. Glazing System: Retained mechanically with gaskets on four sides .

3. Glazing Plane: Match existing storefront
4. Finish: Match existing storefront
5. Fabrication Method: Field-fabricated stick system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Sealants: As recommended by manufacturer.

2.5 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

E. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.6 ACCESSORIES

A. Sill Pan Flashing: Metal flashing installed at new storefront window system

1. Cut flashing to fit in field
2. Match color to existing limestone
3. Reference **Section 076200 Sheet Metal Flashing and Trim** for metal requirements.

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system

2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from [exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels].
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using [shear-block system] [screw-spline system] [head-and-sill-receptor system with shear blocks at intermediate horizontal members] <Insert system>.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
1. Color: Match existing storefront system for all exterior windows.
2. Color: Interior storefront – Black

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
   2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing according to sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, according to sealant manufacturer and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure according to manufacturer's written instructions.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, according to sealant manufacturer's written instructions, to produce weatherproof joints.

3.6 ERECTION TOLERANCES

A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
      c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
   4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 084113

SECTION 09 51 26 – ACOUSTICAL WOOD CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aluratone Ceiling Panels

2. Suspension Systems

1.3 RELATED SECTIONS

A. Section 09 29 00 – Gypsum board Assemblies

B. Section 26 51 19 – LED Interior Lighting.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Suspension System: Rigidly secure acoustic ceiling system including integral mechanical and electrical components with maximum deflection of 1:360.

B. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).

C. Fire Performance Characteristics: Suspended wood ceilings shall conform to Class 1, or A flame spread rating, tested according to ASTM E 84; Flame Spread: 25 or less. Smoke Developed: 450 or less.

1.5 COORDINATION

A. Coordinate layout and installation of the wood slats ceiling systems with other work penetrating the ceiling including light fixtures, HVAC equipment, and fire suppression system components.

1.6 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product.

B. Shop Drawings: Provide layout of suspended wood ceiling and T-rails coordinated with other trades that will penetrate the wood ceiling or interfere with the installation and recessed or surface mounted devices located within the ceiling panels. Indicate method of suspension where interference exists.

C. Selection Samples: For each finish product specified, two complete sets of color brochures representing the manufacturer's full range of available colors and patterns.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment and periodic cleaning and maintenance of all components.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

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

B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.
4. Accepted mock-ups shall be comparison standard for remaining Work

D. Pre-Installation Conference: Convene minimum two weeks prior to starting work of this section. Agenda shall include project conditions, coordination with work of other trades, and layout of items that penetrate ceilings.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in the manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store products off the floor in manufacturer's unopened packaging protected from exposure to harmful environmental conditions and at temperature and humidity conditions as recommended by the manufacturer.

C. A minimum of 72 hours prior to ceiling installation, suspended wood ceilings shall be stored in the room in which they will be installed. Temperature and humidity of the room during this period shall closely approximate those conditions that will exist when the building is occupied.

D. Handle materials to avoid damage.

1.10 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress

1.11 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Plenums have proper ventilation, especially in high moisture areas with no excessive buildup of heat in the ceiling areas.

C. Space shall be fully enclosed with all exterior windows and doors in place, glazed, and weather-stripped. Roof is to be watertight, and all wet trades' work is to be completed, and thoroughly dry.

D. Mechanical, electrical, and other utility services above the ceiling plane shall be completed. No materials should rest against, or wrap around, the ceiling suspension components or connecting hangers.

E. Install only when the temperature and humidity closely approximate the interior conditions that will exist when the building is occupied. Heating and cooling systems shall be operating before, during, and after installation, with the humidity of the interior spaces maintained between 25 and 55 percent, and a temperature between 60 to 90 degrees F.

1.12 EXTRA MATERIALS

A. See Section 01 60 00 - Product Requirements.

B. Deliver materials for Owner's use in maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide product by the following:

1. Rulon International, Rep: Bart Ash, 513-304-4817, bash@rulonco.com
2. Architect approved equal

2.2 MATERIALS

A. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch (3 mm).

2.3 ALURATONE CEILING PANELS

A. Aluratone 830 Micro Groove Series acoustic ceiling panels will have vertical precision grooved face scoring on 10 mm centers. Panels are designed to minimize the appearance of grooves on the face of the wood veneered panels while maintaining very high NRC ratings. Higher NRC ratings can be achieved by using an acoustical blanket behind the panels. The back of the 3/4 inch (19mm) core is drilled so that the intersection of the face grooves and back holes will create openings through the panel. Acoustical absorptive black backing is applied in the factory. Acoustical performance is dependent on project design, application, mounting method, and additional sound absorbent material. Acoustical performance can be achieved up to NRC-0.90.

1. Panel Size: Refer to drawings
2. Face Profile: Aluratone 830 is manufactured with precision ' u-shaped' micro-groove on 0.394 inch (10 mm) centers.
3. Trim and Border Treatment: Provide end caps or junction trims as indicated. Edgebanding.
4. Veneer Species: White Oak
5. Finish: 20 Sheen Clear

2.4 ACCESSORIES

A. C-Hangers: Suspension hangers that are direct-screwed to the panel and hang over the heavy duty-grid. Hangers are made of spring-steel with phosphate pre-treatment and corrosion-resistant coating.

B. Torsion Springs and Saddle Clips: Two parts of a suspension system in which the torsion spring is direct-screwed to the panel and compressed to attach to the saddle clip that is fitted over the heavy duty-grid. Springs and clips are made of spring-steel with phosphate pre-treatment and corrosion-resistant coating.

C. Acoustic Nonwoven Backers: Thin, sound-absorbing fabrics that can be applied to a substrate in order to increase sound attenuation.

D. Integrated Lighting System: Coordinate ceiling panels with lighting specified in Section 26 51 19 – LED Interior Lighting

E. Z-Clips: Male/female aluminum attachment clips, similar to a French cleat but with a thinner profile, used to hang wood wall panels on furring strips.

2.5 SUSPENSION SYSTEMS

A. Main Tees: Standard heavy duty 15/16 inch (24 mm) T-rail specified in Section 09 22 26 - Suspension Systems.

B. Hangers; shall be Suspend ceiling panels from T-rail using torsion springs, C-hangers, or direct screw attachment, as recommended by the manufacturer.

2.6 FABRICATION

A. Edges, borders, and perimeter trims shall be indicated on the Drawings in accordance with the manufacturer's standard design details. All suspended wood ceiling products specified shall be supplied by the wood slat ceiling manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify that T-rail carriers specified in Section 09 22 26 - Suspension Systems are in place, suspended and leveled in a direction perpendicular to the wooden strip direction of the wood panels.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Work shall not begin until the space is fully enclosed and glazed and all wet work is completed and dried out to the satisfaction manufacturer.

C. Temperature shall be at least 65 degrees Fahrenheit during the installation and thereafter.

D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction.

B. Use a laser leveling device to lay out and install the perimeter trim as specified.

C. Suspend panels from the T-rail carrier system as indicated.

D. Make final adjustments to level or contours as required.

3.4 FIELD QUALITY CONTROL

A. Technical Service: Manufacturer shall provide a local Technical Service Representative for on-site training and assistance during the installation process.

B. Environmental Monitoring: Manufacturer shall provide a temperature and humidity sensor to actively monitor the room in which the wood slats shall be installed for a minimum of one week before and up to two weeks after installation has been completed including all of the weeks in between.

C. Upon completion of ceiling installation, the owner's representative shall inspect all finished surfaces to ensure that the work has been completed in a manner satisfactory to the owner. Any deficiencies in the install of the ceiling shall be corrected prior to substantial completion.

3.5 CLEANING AND PROTECTION

A. Clean exposed surfaces of ceiling panel in accordance with manufacturer's instructions.

B. Remove and replace panels and tiles, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 26

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09 58 13 – MONOLITHIC ACOUSTICAL CEILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Suspension systems for perforated gypsum interior ceilings and soffits.
2. Acoustical Insulation for perforated gypsum board ceilings.
3. Extruded aluminum trim for ceiling height changes and material transitions.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Subcontractor is an experienced Installer, approved and trained by product manufacturer to properly install ceiling system.
1. Subcontractor shall provide documentation that they are certified installers of the USG Ensemble® Ceiling System.
2. Subcontractor shall utilize approved equipment and procedures for proper installation.

B. Source Limitations: The Ensemble® Ceiling is to be purchased and installed by a certified single-source provider.

1.5 COORDINATION:

A. Pre-installation conference: Conduct conference at project site [**coordinate all luminaires, sprinklers, exit signs and MEP devices that are to be installed in the ceiling**].

B. Coordinated Shop Drawings: Contractor shall submit coordinated shop drawings that clearly indicate the following components for Architect Approval prior to installation. Shop drawings shall include device alignment, dimensions, center lines and indicate the following:
1. Access panels.
2. Ceiling devices.
3. Ceiling framing.
4. Changes in ceiling height elevation.
5. Control joints
6. Drywall edge profile for USG Compässo™ Elite and associated spice clips for vertical joints.
7. Life safety devices.
8. Light fixtures.
9. MEP grilles.
10. Miscellaneous items located on ceiling.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packaging and store in an enclosed shelter providing protection from damage and exposure to the elements.

1. Store within temperature limits required by manufacturer.
2. Store USG Sheetrock® Brand Ensemble® Four-Sided Taper™ Panels flat.
3. Comply with manufacturer's requirements for safety and handling.

B. Discard joint compounds and sealants that cannot be applied within their stated shelf life.

C. Store accessory materials in a location with constant ambient temperatures of 50 to 80 °F (15 to 27 °C). Avoid exposure to sustained temperatures exceeding 125 °F (52 °C).

1.7 FIELD CONDITIONS

A. Install Ensemble system in an indoor environment that is climate controlled.

B. Comply with ASTM C840 requirements for interior drywall installation: Maintain room temperatures at greater than 40 °F (4.4 °C) at least 48 hours before panel installation and greater than 50 °F (10 °C) at least 48 hours before joint treatment or spray-applied finish application, and continuously during and after application.

C. Avoid exposure and protect from excessive, repetitive or continuous moisture before, during and after installation. Eliminate sources of moisture immediately.

D. Adequate ventilation shall be maintained in the working area during installation and curing period.

1.8 WARRANTY

A. Product is furnished as is to the contractor.

B. Reference Division 01 for General Contractor Obligations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 MONOLITHIC SOUND ABSORBING GYPSUM BOARD SYSTEM

A. Sound Absorbing Gypsum Ceiling, Wall and Framing System:
1. Basis of Design: Subject to compliance with project requirements, the design is based on the following: USG Interiors, LLC, “USG ENSEMBLE® ACOUSTICAL DRYWALL SYSTEM” OR Architect approved equal

2.3 STEEL FRAMING FOR [HORIZONTAL] [AND] [ANGLED CEILING] [AND] [CURVED] SUSPENDED PANELS

A. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Protective Coating: ASTM A 653/A 653M, G40, hot dip galvanized unless otherwise indicated.

A. Perforated Gypsum Board suspension system complies with applicable requirements per ASTM C 645, direct-hung system.

B. Framing System:
a. Deflection criteria: L/240 per ASTM C635.
b. Galvanized Steel: G40 double-web tee, hot-dipped galvanized steel.
2. [HORIZONTAL] [AND] [ANGLED CEILING] Framing Members:
a. USG Drywall Suspension system main tees: DGLW26.
b. USG Drywall Suspension system 4’ cross tees: DGLW-424
3. Attachment devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements, if applicable.

4. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Size: Minimum 12 gage per ASTM C636.

2.4 STEEL FRAMING FOR [VERTICAL] [AND] [HORIZONTAL] [AND] [ANGLED] DIRECT APPLIED PANELS

A. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Protective Coating: ASTM A 653/A 653M, G40, hot dip galvanized unless otherwise indicated.

C. Direct Applied system: Z-Channel with slotted or unslotted web.
1. [Channel Depth: 1" (25mm).]
2. Minimum Base-Metal Thickness: [As indicated on Drawings] [As required by performance requirements for horizontal deflection criteria: L/240 per ASTM C635] [0.0179 inch (0.455 mm)].

D. Impaling Clip: Galvanized impaling clip to retain acoustical insulation until Engineered Gypsum Board is attached.
1. Size: 2 ½" x 1 ½" (62mm x 38mm) by ATS Acoustics or equal. (Ceiling application - x2 clips per NRC Panel, Wall application – x1 clips per NRC panel)

2.5 ENGINEERED GYPSUM-BASED PANEL PRODUCT FOR [CEILING] [AND] [WALL] APPLICATION

A. Engineered Acoustical Gypsum-Based Panel product for [CEILING] [AND] [WALL] application.
1. Perforated non-fire rated gypsum panel with acoustically transparent scrim complies with ASTM C1396 Non-Type X.
2. Subject to compliance with project requirements, the base panel is made from the following: USG Corporation, LLC**,** "USG Sheetrock® Brand Ensemble® Four-Sided Taper™ Panels 5/8".

3. ISO 14040 Environmental Management, Life Cycle Assessment, Principles and Framework:
   a. Carbon emissions per Product Category Rules for North American Gypsum Boards; FPInnovations – Gypsum PCR-2013: v1; Global Warming Potential of [**193 kg CO_2 eq./1000 ft^2 for Eastern USA] [211 kg CO_2 eq./1000 ft^2 for Western USA].**
   b. Water reduction per Product Category Rules for North American Gypsum Boards; FP Innovations – Gypsum PCR-2013: v1 yields a net use of freshwater value of [**0.752 m^3/1000 ft^2 for Eastern USA] [0.953 m^3/1000 ft^2 for Western USA].**
4. UL Type Designation "FC30" (prior to modifications)

5. ASTM C 1396/C 1396M: 5/8” wallboard, non-type X (prior to modifications).
6. ASTM E136 Non-combustibility: Meets or exceeds criteria.
7. ASTM C473:
   a. Core Hardness: Meets or Exceeds 11 (ASTM C473 B)
   b. Flexural Strength (lbf).
      a. Parallel: Not less than 46.
      b. Perpendicular: Not less than 147.
   c. Nail Pull Resistance (lbf) ASTM C473 (B): Not less than 87.
8. Thickness: 5/8 inch (12.7 mm).
9. Length: 8’ (2438.4 mm) or 10’ (3048 mm).
10. Widths: 4’ (1220 mm).
11. Weight: 1.65-1.8 lbs./sq. ft.
12. Edges: Tapered

2.6 ACOUSTICAL BACKER PANEL

A. Acoustical Backer Panel: USG Interiors, LLC, “USG Ensemble™ High-NRC Backer Panel”.
   1. Classification: Provide un-faced acoustical panels with the following physical attributes:
      a. NRC: Not less than 0.80.
      b. CAC: Not less than 40.
      c. Edge/Joint Detail: SQ Square.
      d. Panel Thickness: [1 inch (25.4 mm)] [2 inch (50.8 mm)]
      e. Modular Size: 23.5 by 48 inches (596.9 by 1220 mm).
      f. Recycled Content: Not less than 66%.
   2. High Recycled Content Product: Classified as containing greater than 50% total recycled content. Total recycled content is based on product composition of post-consumer and pre-consumer post-industrial recycled content per FTC guidelines.
   3. VOC Emissions: Meets CA Specification 01350, CHPS listed for low emitting materials.

2.7 [CEILING] [AND] [WALL] PANEL JOINT TREATMENT

A. Perforated Gypsum Board Joint Treatment.
   1. General: Comply with ASTM C 475/C 475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board:
      a. USG Sheetrock® Brand Easy Sand™ Joint Compound
      b. USG Sheetrock® Brand Paper Joint Tape.
      c. USG Sheetrock® Brand All Purpose Joint Compound
      d. USG Sheetrock® Brand Ensemble™ Ceiling Compound
   2. Application:
      a. Joint Compound for Interior Gypsum Board: For each coat, use formulation that complies with USG Ensemble® Acoustical Monolithic Ceiling System applied on previous and or successive coats.
   3. Prefilling:
      a. At open joints or beveled panel edges, use USG Sheetrock® Brand Easy Sand™ Joint Compound.
   4. Embedding and First Coat:

a. For embedding tape, use USG Sheetrock® Brand All Purpose Joint Compound and embed USG Sheetrock® Brand Paper Joint Tape.

5. Finish Coat:

For finish coats on joints, fasteners, and trim flanges, as well as all 3 finish coats over joint tape, use USG Sheetrock® Brand Ensemble™ Ceiling Compound. Finish to create a final coat equal to a Level 4 finish. **DO NOT** SKIM COAT OVER PERFORATIONS.

2.8 [CEILING] [AND] [WALL] PANEL SPRAY-APPLIED FINISH

A. Acoustically Transparent Finish

1. USG Interiors, LLC, “USG Ensemble™ Spray-Applied Finish”:
   a. Finish: Fine Finish.
   b. [Color: White (standard)]
   c. [Color: Black]
   d. [Custom Color:
      a) Benjamin Moore
      b) Sherwin Williams
      c) Pantone]

2. Classification: Provide acrylic based spray-applied finish complying with USG Ensemble™ Spray-Applied Finish.

2.9 ACCESSORIES

A. Gypsum Board Trim Accessories.

1. Trim Accessories: Galvanized steel sheet per ASTM 1047: Provide manufacturer approved and tested metal trim that is chemically compatible with the specified ceiling system.
   a. USG Sheetrock Brand Metal Trim:
      a. Corner Bead
      b. Reveal Joint
      c. L Bead
      d. U Bead
      e. Control Joint
      f. USG Sheetrock® Brand Paper Faced Metal Trim.

B. Extruded-Aluminum Edge Moldings and Trim.

1. Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following: Provide manufacturer approved and tested metal trim that is chemically compatible with the specified ceiling system.
   a. Drywall Ceilings: USG Compässo™ Elite for Drywall, height: [2 1/2” (40)], [4” (100)], [6” (150)] or [8” (200)].

b. Drywall to upper grid ceiling: USG Compässo™ Elite Transitions DAS, height: [2" (50)], [3" (75)], [4" (100)], [5" (125)] or [6" (150)].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, verify that installed building services to not interfere with work.

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

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) O.C.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, and true to line, with connections securely fastened.

C. Install drywall suspension grid framing, and blocking to support fixtures, equipment services, demountable partition supports, or similar construction.

D. Install bracing at terminations in assemblies.

E. This product system installation is similar to a conventional drywall installation. However, there are some differences in both materials and methods of installation that make this

system unique. Installers should review and follow all directions of this installation instruction guide.

F. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMING SYSTEM

A. Suspended System
1. Determine the finished ceiling height. If the ceiling extends to the sidewalls, screw attach DGWM24 wall angle to the sidewalls at 5/8” above the finished ceiling height. Fasteners must be in the framing members. Attach hanger wires to structure above using the appropriate method. Hanger wires shall be spaced 48” OC max in each direction. Using pliers, bend the hanger wires.
2. Insert the hanger wires through the utility holes in the DGLW26 Main Tees. The DGLW26 Main Tees will run perpendicular to the cross tees at 48” OC max. The hanger wires must be within 5 degrees of plumb. Secure the DGLW-424 cross tees to the DGLW26 Main Tees by snapping the clip into the cross-tee holes on the main tee.
3. The cross tees can be spaced at 16” or 24” OC. If the ceiling extends wall to wall, square up the main tees and screw attach to the DGWM24 wall angle.

3.5 Panels

A. Suspended System and Curved System
1. For high NRC system performance, lay the USG Ensemble® High-NRC Backers in the framing system from above. The acoustical backers are 15.5”x 47.75” or 23.5” x 47.75” and lay on the back of the flanges of the main tees. Installation is similar to standard lay-in ceiling panels. Do not screw attach USG Ensemble® High-NRC Backers panels to the main tees.

3.6 Perforated Gypsum Board Installation

A. Suspended System

1. The USG Sheetrock® Brand Ensemble® Four-Sided Taper™ Panels can be cut like standard Sheetrock wallboard panels using a T square and utility knife. Score the face of the panels at the desired length, making sure to cut completely through the fiberglass face scrim. Snap the panels and then cut completely through the back scrim. No marks can be made in the field of the panels unless they are covered by USG Sheetrock® brand Ensemble™ Ceiling Compound prior to spraying. (I.e., pencil, marker, or similar).

2. Fasten the perforated panels parallel to the DWSS Main Tees with screw spacing at 12” OC in the field and 8” OC on the butt ends using 1-1/4” fine thread bugle head drywall screws. The fasteners must be in the field of the board, not the perforations. The fastener head should be just below the surface without tearing the fiberglass scrim.

Tip: Break all butt joints on DWSS Cross Tees and avoid breaking panel joints on the DWSS Main Tees.

3. A router or keyhole saw can be used to cut penetrations like standard wallboard.

4. Install beads and trims using the same method as standard wallboard. If the ceiling design is a floating island, trim the perimeter using USG Compässo™ Elite for Drywall.

3.7 Joint Finishing (Suspended System, Curved System, Direct Mount, Direct Mount – Return Air Plenum)

A. The joints are finished using the USG Sheetrock® Brand All Purpose Joint Compound, Sheetrock® Brand Paper Joint Tape, and USG Sheetrock® Brand Ensemble™ Ceiling Compound. It is imperative to finish the joints as flat and level with the surface of the board as possible. Even slightly hollow or crowned joints will show as imperfections under critical lighting after the finish is applied.

B. Embed joint tape with the USG Sheetrock® Brand All Purpose Joint Compound. This can be done by hand with a joint knife, or a standard bazooka. Wipe excess joint compound with a joint knife and allow to dry completely.

C. Spot all fastener heads with USG Sheetrock® Brand Ensemble™ Ceiling Compound using a 1” or 2” joint knife. Keep the compound area small to minimize covering the perforations.

D. After the bed and tape coat is dry, apply a second coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound on all the fasteners. Then apply the fill coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound over the joints. This can be done using an 8” joint knife or an 8” flat box with the blade set flat.

E. After the fill coat is dry, apply a third coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound on all the fasteners. Then apply the finish coat of USG Sheetrock® Brand Ensemble™ Ceiling Compound over the joints. This can be done using a 10” joint knife or a 10” flat box with the blade set for a slight crown.

F. All joints must be filled and leveled with the surface of the board. Hollow joints require additional USG Sheetrock® Brand Ensemble™ Ceiling Compound and crowned joints must be sanded level using a flat sander. It is important to thoroughly check each joint down the entire length for flatness, not just at a few random locations.

G. A light sanding of the entire surface will help prep for the spray process but avoid over sanding the fiberglass scrim as much as possible.

3.8 Spray-Applied Finish (Suspended System, Curved System, Direct Mount, Direct Mount – Return Air Plenum)

A. Note: The proper spray equipment must be used to achieve acoustical performance and esthetics.

B. Please contact your local USG Contractor Specialty Representative for specifications of required spray equipment to apply Ensemble™ Spray-Applied Finish.

C. Mask off all areas that need protecting from overspray with plastic sheathing. Use a floor protector as required. Set up the spray machine and compressor using the proper hoses. Set the air and material pressure to achieved desired finish.

D. The USG Ensemble™ Spray-Applied Finish must be mixed in the 5-gallon bucket prior to filling spray machine hopper. Use a 450-rpm electric drill and a USG Sheetrock® 4-blade mixing paddle, blend until it is a smooth creamy consistency. Before any water is added, check the viscosity using a material thickness gauge provided by the spray equipment manufacturer (small steel ball on a cable). Place the ball on the Finish and let go, if the ball sinks into the Finish and is no longer visible in three seconds the material is ready to put in the sprayer. If the ball is still visible after three seconds, add water in 4-ounce increments and remix until the ball sinks in three seconds.

E. Prime sprayer equipment with 5 gallons of clean potable water. With the nozzle air off, cycle water through the hose and spray gun back into the hopper for 30 seconds and then drain out the water out of the hopper. Pour the 5 gallons of mixed finish into the hopper. With the nozzle air still off, cycle the remaining water out of the hose into a separate container. When the spray finish has reached the gun, cycle the spray finish through the hose and gun back into the hopper until it is flowing smoothly through the machine.

F. The Ensemble™ Spray-Applied Finish must be applied in a minimum of four coats to achieve the proper appearance and sound performance. Apply each coat very lightly with 36” minimum gun clearance. Start in one corner and work progressively across the ceiling. Immediately cross hatch. Once the finish is dry to the touch (approx. 20-40 min), use a soft rubber squeegee trowel to remove loose Finish, then recoat using the same technique. Apply successive coats until the desired appearance is achieved and the perforations are no longer visible through the Finish.

G. Maintain proper jobsite conditions and wear proper protective equipment (safety goggles, NIOSH- approved respirator, coveralls) while applying the finish.

END OF SECTION 095813

SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers."
2. Section 211100 "Facility Fire-Suppression Water-Service Piping" for sizes, types, and finishes for hoses, hose valves, hose couplings, nozzles, and hose racks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Samples for Initial Selection: For each type of exposed finish required.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.4 CLOSEOUT SUBMITTALS

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

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.6 SEQUENCING

A. Apply decals on field-painted fire-protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Subject to compliance with requirements, provide one of the following:
   a. Fire End & Croker Corporation.
   b. Guardian Fire Equipment, Inc.
   c. J. L. Industries, Inc., a division of Activar Construction Products Group.
   d. Larsen's Manufacturing Company.
   e. Nystrom Building Products.
   f. Potter Roemer LLC.
   g. Strike First Corporation of America.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

D. Surface Mounted Cabinet:

E. Cabinet Trim Material: Steel sheet.

F. Door Material: Steel sheet.

G. Door Style: Vertical duo panel with frame.

H. Door Glazing: Tempered float glass (clear).

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting lever handle with cam-action latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

    a. Identify fire extinguisher in fire-protection cabinet with the words " FIRE EXTINGUISHER."

        1) Location: Applied to cabinet door.
        2) Application Process: Decals.
        3) Lettering Color: Red.
        4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

    a. Finish: Baked enamel or powder coat.
    b. Color: As selected by Architect from full range of industry colors and color densities.

2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

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

2.3 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking cabinets will be installed.

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

3.2 PREPARATION

A. Prepare surfaces for surface mounted fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide surface mounted fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification: Apply decals at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

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SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Wet-Chemical Type: UL-rated 2-A:1-B:C:K, 2.5-gal. nominal capacity, with potassium acetate, citrate, or carbonate-based chemical in stainless-steel container; with pressure-indicating gage.

1. Provide wet chemical extinguishers in kitchen area and where noted.

C. Multipurpose Dry-Chemical Type: UL-rated 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

1. Provide this type throughout facility unless noted otherwise.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 10 44 16

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SECTION 10 73 20 – AWNINGS AND CANOPIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Extruded aluminum overhead hanger rod style canopies

1.3 COORDINATION

A. Confirm dimensions prior to preparation of shop drawings when possible.

B. If requested, supply manufacturer's standard literature and specifications for canopies.

C. Submit shop drawings showing structural component locations/positions, material dimensions and details of construction and assembly.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product.

B. Shop Drawings:

1. For installed components indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for
their preparation.
2. Anchor-Bolt Plans: Include location, diameter, and projection of anchor bolts required to attach metal canopy to foundation.
3. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
4. Roof Layout Drawings: Show layouts of panels on support framing, details of edge conditions, joints, panel profiles, corners, custom profiles, supports, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work.

C. Samples for initial selection: Manufacturer's color charts showing the full range of colors available for each type of product with factory-applied color finishes:

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Erector Qualifications: An erector with a minimum of five years of experienced who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal canopy systems that are similar to those indicated for this Project in material, design, and extent.

C. Manufacturer Qualifications: A minimum of twenty five years of experienced in manufacturing overhead canopy systems similar to those indicated for this Project and with a record of successful in-service performance.

1. Manufacturer to have an annual audit of its quality assurance program.
2. Engineering Responsibility: Engineering analysis by a qualified professional engineer.

D. Welding: Qualified procedures and certified welding personnel according to the following:

1. Welding shall be in accordance to AWS D1.1, "Structural Welding Code Steel".
2. Steel Shop connections shall be welded and field connections shall be bolted (Unless otherwise noted in the drawings). Shop welds may be changed to field welds with the approval of the project engineer.
3. Slag shall be cleaned from welds and prime painted with rust-inhibitive primer.

E. Source Limitations: Obtain pre-engineered metal canopy through one source from a single manufacturer who shall manufacture and install the canopy.

F. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package roof and wall panels for protection during transportation and handling.

B. Handling: Unload, store, and erect roof and wall panels to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weather tight and ventilated covering. Store roof and wall panels to ensure dryness. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit roof and fascia panel installation to be performed according to manufacturer's written instructions and warranty requirements.

B. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Field Measurements: The Contractor shall verify locations and elevations of footings relative to finish grade prior to fabrication of columns and other canopy components.

1. Established Dimensions: The Contractor will, where field measurements cannot be made, establish dimensions and proceed with fabrications of metal canopy without field measurements. Contractor is responsible to coordinate footer locations and elevations with any interferences with or attachments to abutting structures.

D. Site Conditions: Must meet manufacturer’s Required Job Site Conditions for Installation.

1. Anchor bolts must be installed per erection drawings. Footings need to be free of debris and anchor bolt threads undamaged
2. All work surfaces must be even with no exposed product lines

1.9 WARRANTY

A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

B. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights. Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Warranty Period: One year from date of Substantial Completion.

C. Special Warranty on Panels: Written warranty, executed by manufacturer agreeing to repair or replace roof and fascia panels that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

D. Special Warranty on Panel Finishes: Written warranty, signed by manufacturer agreeing to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking peeling, and loss of film integrity.

1. Warranty Period for Roof Panels: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide product by the following:

1. Mapes Architectural Canopies
2. Queen City Awning
3. Architect approved equal

2.2 MATERIALS

A. Decking and fascia shall be extruded aluminum, alloy 6063-T6.

B. Decking Shall be 2 3/4” Extruded .078” Decking

C. Hanger rods and attachment hardware shall be powder coated to match canopy.

D. Fascia shall be standard 8” extruded “J” style (minimum .125 aluminum)

2.3 FINISHES

A. Standard factory options are clear anodized, bronze baked enamel or white baked enamel.

B. Optional finishes include standard two-coat Kynar ® colors.

2.4 FABRICATION

A. All connections shall be mechanically assembled utilizing 3/16” fasteners with a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.

B. Decking shall be designed with interlocking extruded aluminum members with mechanical fasteners field applied to provide structural integrity for the completed assembly.

C. Concealed drainage. Water shall drain from covered surfaces into integral fascia gutter and directed to either the front for front drainage or to the rear for ground level discharge via one or more designated downspouts.

D. Accessories: General, provide fabricator's standard accessories, including fasteners, clips, anchorage devices and attachments.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances, including oil, grease, rolling compounds, incompatible primers, and loose mill scale that impair bond of erection materials.

B. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

3.2 ERECTION OF STRUCTURAL STEEL

A. Erect metal canopy system according to manufacturer's written instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal canopy system manufacturer's professional engineer.

C. Set structural framing in locations and to elevations indicated and according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base plates and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces before setting base plates and bearing plates. Clean bottom surface of base plates and bearing plates.

1. Set base plates and bearing plates for structural members on leveling nuts.
2. Tighten anchor bolts after supported members have been positioned and plumbed.
3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure. Shrinkage-Resistant Grout to be provided and installed by the General Contractor. Comply with manufacturer's written instructions for proprietary grout materials.

E. Align and adjust framing members before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Make adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

F. Primary Framing: Erect framing true to line, level, plumb, rigid, and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation.

1. Make field connections using high-strength bolts. Tighten bolts by turn-of-the-nut method.

G. Secondary Framing: Erect framing true to line, level, plumb, rigid, and secure. Fasten secondary framing to primary framing using clips, non-high-strength bolts, and or screws as indicated on manufacturers erection drawings.

H. Bracing: Install bracing in roof where indicated on manufacturers erection drawings.

3.3 EXAMINATION

A. Confirm that surrounding area is ready for the canopy installation.

B. Installer shall confirm dimensions and elevations to be as shown on shop drawings.

C. Erection shall be performed by an approved installer and scheduled after all concrete, masonry and roofing in the area is completed.

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

3.4 INSTALLATION

A. Installation shall be in strict accordance with manufacturer’s shop drawings. Particular attention should be given to protecting the finish during handling and erection.

3.5 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. After installation, entire system shall be left in a clean condition.

END OF SECTION 10 73 20

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SECTION 14 24 10 – MODERNIZATION OF HYDRAULIC ELEVATOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the engineering, furnishing, and installation of the complete hydraulic elevator system as described herein.

B. Passenger Elevator shall be oil hydraulic, non-proprietary microprocessor control system, and power-operated car and hoistway doors. Elevator shall be Class “A” loading rated.

C.

ELEVATOR SCHEDULE	
Elevator Number	1
Overall Platform Size	Existing to Remain
Clear Inside Platform	6’-11.5”W x 4’-2”D
Rated Load – lb	2500
Contract Speed - fpm	125
Total Travel – ft	14’-0”
Floors Served	2
Number of Openings	2
Entrance Type & Size	Existing to Remain
Plunger Size	Existing to Remain

1.2 QUALIFICATIONS

A. Approval by the Owner and Architect is required for products and services of proposed manufacturers, suppliers, installers, and shall be contingent upon submission of certificates by the Contractor stating the following:

1. Elevator contractor is currently and regularly engaged in the installation of elevator equipment as one of his principal products.
2. Elevator contractor shall have five (5) years of successful experience, trained supervisory personnel, and facilities to install elevator equipment specified herein.
3. Elevator Mechanic (Installer) shall have passed a Mechanic Examination approved by the U.S. Department of Labor and have technical qualifications of at least five years of experience in the elevator industry or 10,000 hours of field experience working in the elevator industry with technical update training. Apprentices shall be actively pursuing Certified Elevator Mechanic status. Certification shall be submitted for all workers employed in this capacity.

B. Welding at the project site shall be performed by certified welders who have previously qualified by test as prescribed in American Welding Society Publications AWS DI.1 to perform the type of work required. Certificates shall be submitted for all workers employed in this capacity. A welding or hot work permit is required for each day and shall be obtained from the VAMC safety department. Request permit one day in advance.

C. Electrical work shall be performed by a Licensed Master Electrician and Licensed Journeymen Electricians as requirements by NEC. Certificates shall be submitted for all workers employed in this capacity.

D. Approval will not be given to elevator contractors and manufacturers who have established on prior projects, either government, municipal, or commercial, a record of unsatisfactory elevator installations, have failed to complete awarded contracts within the contract period, and do not have the requisite record of satisfactorily performing elevator installations of similar type and magnitude.

E. Approval of Elevator Contractor's equipment will be contingent upon their providing factory training, engineering and technical support, including all manuals, wiring diagrams, and tools necessary for adjusting, maintenance, repair, and testing of equipment to the Owner for use by the Owner's designated Elevator Maintenance Service Provider. Identifying an elevator maintenance service provider that shall render services within two hours of receipt of notification, together with certification that the quantity and quality of replacement parts stock is enough to warranty continued operation of the elevator installation.

F. The Contractor shall provide and install safety devices that have been subjected to tests witnessed and certified by an independent professional testing laboratory that is not a subsidiary of the firm that manufactures supplies or installs the equipment.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification.

B. American Society of Mechanical Engineers (ASME):

1. A17.1 - Safety Code for Elevators and Escalators
2. A17.2 - Inspectors Manual for Electric Elevators and Escalators

C. National Fire Protection Association:

1. NFPA 13 - Standard for the Installation of Sprinkler Systems
2. NFPA 70 - National Electrical Code (NEC)
3. NFPA 72 - National Fire Alarm and Signaling Code
4. NFPA 101 - Life Safety Code
5. NFPA 252 - Fire Test of Door Assemblies

D. International Building Code (IBC)

E. American Society for Testing and Materials (ASTM):

1. A1008/A1008M-09 - Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability
2. E1042-02 - Acoustically Absorptive Materials Applied by Trowel or Spray

F. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-58 - Pipe Hangers and Supports

G. Society of Automotive Engineers, Inc. (SAE)

1. J517-91 - Hydraulic Hose, Standard

H. Gages:

1. For Sheet and Plate: U.S. Standard (USS)

2. For Wires: American Wire Gauge (AWG)

I. American Welding Society (AWS):

1. D1.1 - Structured Welding Code – Steel

J. National Electrical Manufacturers Association (NEMA):

1. LD-3 - High-Pressure Decorative Laminates

K. Underwriter's Laboratories (UL):

1. 486A - Safety Wire Connectors for Copper Conductors
2. 797 - Safety Electrical Metallic Tubing

L. Institute of Electrical and Electronic Engineers (IEEE)

M. Regulatory Standards:

1. Americans with Disabilities Act

1.4 SUBMITTALS

A. Submit in accordance with Specification Requirements.

B. Before execution of work, furnish information to evidence full compliance with contract requirements for proposed items. Such information shall include, as required: Manufacturer's Name, Trade Names, Model or Catalog Number, Nameplate Data (size, capacity, and rating) and corresponding specification reference (project specification number and paragraph). All submitted drawings and related elevator material shall be forwarded to the Architect.

C. Shop Drawings:

1. Complete scaled and dimensioned layout in plan and section view showing the arrangement of equipment and all details of each elevator unit specified including:
   a. Complete layout showing location of storage tank/pump assembly, controller, piping layout, outside diameter of cylinder/plunger assembly, size of car platform, car frame members, and support assembly.
   b. Top and bottom clearances and over travel of the car.
   c. Location of main line switch/shunt trip circuit breaker, switchboard panel, light switch, and feeder extension points in the machine room.
2. Drawings of hoistway entrances and doors showing details of construction and method of fastening to the structural members of the building.

D. Samples:

1. One each of stainless steel, 75 mm x 125 mm (3 in. x 5 in.).
2. One each of baked enamel, 75 mm x 125 mm (3 in. x 5 in.).
3. One each of color floor covering.
4. One each of protection pads, 75 mm x 125 mm (3 in. x 5 in.) if used.
5. One each car and hoistway Braille plate sample.
6. One each car and hall button sample.
7. One each car and hall lantern/position indicator sample.
8. One each wall and ceiling material finish sample.
9. One each car lighting sample.

E. Name of manufacturer, type or style designation, and applicable data of the following equipment shall be shown on the elevator layouts:

1. Storage tank/pump assembly.
2. Pump and motor, HP and RPM rating, Voltage, Starting and Full Load Ampere, Number of phases, and Gallons per minute.
3. Controller.
4. Starters and Overload Current Protection Devices.
5. Car Safety Device; Rupture Valve and Manual Shut Off Valves.
6. Electric Door Operator; HP, RPM, Voltage, and Ampere rating of motor.
7. Hoistway Door Interlocks.
8. Car Buffers; maximum and minimum rated load, maximum rated striking speed and stroke.
9. Cab Ventilation Unit; HP rating and CFM rating.

F. Dimensioned drawings showing details of:

1. All signal and operating fixtures.
2. Car slide guides/roller guides.
3. Hoistway door tracks, hangers, and sills.
4. Door operator, infrared curtain units.

G. Cut sheets or drawings showing details of controllers and supervisory panels.

H. Furnish certificates as required under: Paragraph "QUALIFICATIONS".

1.5 WIRING DIAGRAMS

A. Provide three complete sets of field wiring and straight-line wiring diagrams showing all electrical circuits in the hoistway, machine room and fixtures. Install one set coated with an approved plastic sealer and mounted in the elevator machine room.

B. In the event field modifications are necessary during installation, diagrams shall be revised to include all corrections made prior to and during the final inspection. Corrected diagrams shall be delivered to the Architect within 30 days of final acceptance.

C. Provide the following information relating to the specific type of microprocessor controls installed:

1. Owner's information manual, containing job specific data on major components, maintenance, and adjustment.
2. System logic description.
3. Complete wiring diagrams needed for field troubleshooting, adjustment, repair and replacement of components. Diagrams shall be base diagrams, containing all changes and additions made to the equipment during the design and construction period.
4. Changes made during the warranty period shall be noted on the drawings in adequate time to have the finalized drawings reproduced for mounting in the machine room no later than six months prior to the expiration of the warranty period.

1.6 WORK SCHEDULE

A. Before starting work submit a detailed work schedule for approval and arrange with Owner sequence of procedure, means of access to premises, space for storage, use of approaches, corridors, stairways, elevators, location of temporary partitions, disposal of trash and recyclable materials. The Owner must be notified, in writing, in advance of starting work on elevator; refer to Owner’s front end documents for number of days’ notice required. No work may begin on any elevator until all materials for that elevator have been delivered to the site. The phasing of work on the elevator shall be coordinated with the City Project Manager.

1.7 SAFETY PRECAUTIONS

A. The building will be occupied during execution of work. Work shall be conducted in a manner to afford maximum protection of public, employees, building, and facilities to prevent unreasonable delay or interference with normal functioning of the building activities.

B. Provide fire extinguishers that are readily available always.

C. It shall be the obligation of the contractor to maintain a free and clear passageway in each elevator lobby. Parts and tools shall be kept within the confines of entrance partitions. Trash and debris shall be removed daily.

D. Provide fire rated partition during the modernization of elevators. Barrier shall extend to the full height of the elevator entrance and shall be dust and vapor proof with dust absorbing mats at access points.

1.8 REMOVAL Of MATERIALS AND EQUIPMENT

A. Material and equipment that are not specified to be reused or retained under contract shall be removed daily from the site at the expense of the contractor. The contractor shall receive title to all material and equipment not specified to be reused as of date of withdrawal from service. The Owner does not warranty condition of the material to which contractor shall obtain title, nor shall the Owner be liable for damage before or after title passes to contractor.

1.9 PERFORMANCE STANDARDS

A. The elevators shall meet the following:

1. Contract speed is high speed in either direction of travel with rated capacity load in the elevator. Speed variation under all load conditions, regardless of direction of travel, shall not vary more than five (5) percent.
2. The controlled rate of change of acceleration and retardation of the car shall not exceed 0.1G per ft/s/s and the maximum acceleration and retardation shall not exceed 0.2G per ft/s/s.
3. Starting, stopping, and leveling shall be smooth and comfortable without appreciable steps of acceleration and deceleration.

B. The door operator shall open the car door and hoistway door simultaneously at 2.5-feet per second and close at 1-foot per second.

C. Pressure: Fluid system components shall be designed, and factory tested for 500 psi operating pressure.

D. Floor level stopping accuracy shall be within 3 mm (.125 in.) above or below the floor, regardless of load condition.

E. Noise and Vibration Isolation: All elevator equipment including their supports and fastenings to the building, shall be mechanically and electrically isolated from the building structure to minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of building.

F. Sound Isolation: Noise level relating to elevator equipment operation in machine room shall not exceed 80 decibels. All db readings shall be taken three (3) feet off the floor and three (3) feet from equipment.

1.10 WARRANTY

A. A one-year Warranty shall commence after final inspection, completion of performance test, and upon full acceptance of the installation and run concurrent with the guarantee period of service.

B. During warranty period if a device is not functioning properly in accordance with specification requirements, more maintenance than the contract requires keeping device operational, device

shall be removed and a new device meeting all requirements shall be installed as part of work until satisfactory operation of installation is obtained. Period of warranty shall start anew for such parts from date of completion of each new installation performed, in accordance with foregoing requirements.

1.11 POWER SUPPLY

A. For power supply in machine room, see Electrical specifications, and Electrical drawings.

B. Main Line Fused Disconnect Switch/Shunt Trip Circuit Breaker for each controller shall be located inside the machine room at the strike side of the machine room door and lockable in the “Off” position.

1. Provide micro-switch in main line disconnect to turn off power to battery source when disconnect is turned off.

C. Provide Surge Suppressors to protect the elevator equipment.

1.12 EMERGENCY POWER SUPPLY

A. Elevator is not connected to emergency power, but is to be equipped with a battery powered lowering device as a part of this Work.

1.13 ELEVATOR MACHINE ROOM

A. Reuse existing machine room and meet the requirements of ASME A17.1, NFPA 70, NFPA 101 and IBC.

B. Locate the shunt trip disconnect and machine room light switch where indicated on the electrical drawings.

1.14 HOISTWAY LIGHTING

A. Refer to electrical drawings for hoistway lighting in the pit and at the top of the shaft.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Where stainless steel is specified, it shall be corrosion resisting steel Type 304, with Number 4 finish on exposed surfaces. Stainless steel shall have the grain of belting in the direction of the longest dimension and surfaces shall be smooth and without waves. During installation stainless steel surfaces shall be protected with a suitable material.

B. Where cold rolled steel is specified, it shall be low-carbon steel rolled to stretcher level standard flatness, complying with ASTM A109.

2.2 MANUFACTURED PRODUCTS

A. Materials, devices, and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items. The elevator equipment, including controllers, door operators, and supervisory system shall be the product of manufacturers of established reputation, provided such items are capably engineered and produced under coordinated specifications to ensure compatibility with the total operating system.

1. Approved Elevator Vendors:
   a. Schindler Elevator – (Ryan Schenk, 513-313-3579, ryan.schenk@schindler.com)
   b. KONE Inc (Ryan Batik, 614-769-2654, ryan.batik@kone.com)
   c. TK Elevator (Kelsey Glockner, 513-432-1625, kelsey.glockner@tkelevator.com)
   d. OTIS ELEVATOR (Emily Griggs, 937-701-2720, Griggs, emily.griggs@otis.com)

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for the final assembled unit. Components shall be compatible with each other and with the total assembly for the intended service.

C. Mixing of manufacturers related to a single system or group of components shall be identified in the submittals.

D. Furnish four (4) keys for each individual switch or lock. Provide different key tumblers for different switch and lock functions. Each key shall have a tag bearing a stamped or etched legend identifying its purpose.

2.3 CONDUIT AND WIREWAY

A. Reuse existing when possible and provide new conduit and wireway where needed. Install electrical conductors, except traveling cable connected to the elevator, in rigid zinc-coated steel or aluminum conduit, electrical metallic tubing or metal wireways. Rigid conduit smaller than .75 inch or electrical metallic tubing smaller than .50-inch electrical trade size shall not be used. All raceways completely embedded in concrete slabs, walls, or floor fill shall be rigid steel conduit. Wireway (duct) shall be installed in the hoistway and to the controller and between similar apparatus in the elevator machine room. Fully protect self-supporting connections, where approved, from abrasion or other mechanical injury. Flexible metal conduit not less than .375-inch electrical trade size may be used, not exceeding 18 inches in length unsupported, for short connections between risers and limit switches, interlocks, and for other applications permitted by NEC.

B. All conduits terminating in steel cabinets, junction boxes, wireways, switch boxes, outlet boxes and similar locations shall have approved insulation bushings. Install a steel lock nut under the bushings if they are constructed completely of insulating materials. Protect the conductors at ends of conduits not terminating in steel cabinets or boxes by terminal fittings having an insulated opening for the conductors.

C. Rigid conduit and EMT fittings using set screws or indentations as a means of attachment shall not be used.

D. Connect motors or other items subject to movement, vibration or removal to the conduit or EMT systems with flexible, steel conduits.

2.4 CONDUCTORS

A. Remove existing and provide new conductors, excluding the traveling cables. Conductors shall be stranded or solid coated annealed copper. Where 16 and 18 AWG are permitted by NEC, single conductors or multiple conductor cables Conductors for control boards shall be in accordance with NEC. Joints or splices are not permitted in wiring except at outlets. Tap connectors may be used in wireways provided they meet all UL requirements.

B. Provide all conduit and wiring between machine room, hoistway, and fixtures.

C. All wiring must test free from short circuits or ground faults. Insulation resistance between individual external conductors and between conductors and ground shall be a minimum of one megohm.

D. Where size of conductors is not given, voltage and amperes shall not exceed limits set by NEC.

E. Provide equipment grounding. Ground the conduits, supports, controller enclosure, motor, platform and car frame, and all other non-current conducting metal enclosures for electrical equipment in accordance with NEC. The ground wires shall be copper, green insulated and sized as required by NEC. Bond the grounding wires to all junction boxes, cabinets, and wire raceways.

2.5 TRAVELING CABLES

A. Remove existing and provide new flexible traveling cables conforming to the requirements of NEC. Traveling cables shall run from the junction box on the car directly to the controller. Junction boxes on the car shall be equipped with terminal blocks. Terminal blocks having pressure wire connectors of the clamp type that meet UL 486A requirements for stranded wire may be used in lieu of terminal eyelet connections. Terminal blocks shall have permanent indelible identifying numbers for each connection. Cables shall be securely anchored to avoid strain on individual terminal connections. Flame and moisture resistant outer covering must remain intact between junction boxes. Abrupt bending, twisting and distortion of the cables shall not be permitted.

B. Provide spare conductors equal to 10 percent of the total number of conductors furnished, but not less than 5 spare conductors in each traveling cable.

C. Provide shielded wires for the auto dial telephone system within the traveling cable for card reader, one (1) RG-6 Ethernet cable, two (2) pair 14-gauge wires for 110 Volt power supply.

D. If traveling cables contact the hoistway or elevator due to sway or change in position, provide shields or pads to the elevator and hoistway to prevent damage to the traveling cables.

E. Hardware cloth may be installed from the hoistway suspension point to the elevator pit to prevent traveling cables from rubbing or chafing and securely fastened and tensioned to prevent buckling. Hardware cloth is not required when traveling cable is hung against a flat wall.

2.6 CONTROLLER AND SUPERVISORY PANEL

A. Non-Proprietary Controller Manufacturer:

1. Schindler HX Controller
2. Elevator Controls Pixel Controller
3. Architect Approved (Proprietary) Equal

B. Remove existing and provide new non-proprietary UL/CSA Labeled Controller. Mount all assemblies, power supplies, chassis switches, and relays on a steel frame in a NEMA Type 1 General Purpose Enclosure. Cabinet shall be securely attached to the building structure.

C. Properly identify each device on all panels by name, letter, or standard symbol which shall be neatly stencil painted or decaled in an indelible and legible manner. Identification markings shall be coordinated with identical markings used on wiring diagrams. The ampere rating shall be marked adjacent to all fuse holders. All spare conductors to controller and supervisory panel shall be neatly formed, laced, and identified.

2.7 MICROPROCESSOR CONTROL SYSTEM

A. Provide a non-proprietary microprocessor control system with absolute position/speed feedback to control dispatching, signal functions, door operation, and pump motor control. Complete details of the components and printed circuit boards, together with a complete operational description, shall be submitted for approval. Provide closed transition SCR soft start.

B. Controller manufacturer shall provide factory training, engineering and technical support, including all manuals, wiring diagrams, and tools necessary for adjusting, maintenance, repair, and testing of equipment to the Owner for use by the Owner's designated Elevator Maintenance Service Provider.

C. Provide a low oil control feature that shall shut off the motor and pump and return the elevator to the lowest landing. Upon reaching the lowest landing, doors will open automatically allowing passengers to leave the elevator, and then doors shall close. All control buttons, except the door open button, alarm bell button, and the call for help button shall be made ineffective.

D. For elevator microprocessor control systems, provide maintenance diagnostic tools, electrical schematic wiring diagrams, any and all access codes or passwords required for all maintenance functions, including diagnostics, adjustment, and parameter reprogramming. Tools must be built into the control system and shall function for the life of the equipment. Tools that require recharging or reprogramming shall not be used. Provide complete operations and maintenance manuals including diagnostics instruction for troubleshooting the microprocessor system. Parts for the microprocessor must be available to the owner or the owner's designated representative at the manufacturer's published list price for the life of the system.

E. The following information relating to the elevator control system shall be included:

1. Owner's manual containing data on major components, recommended spare parts, maintenance, and adjustment.
2. Adjuster's manual.
3. "AS-BUIILT" wiring diagrams.
4. Description of system operating features.

F.

2.8 EMERGENCY POWER OPERATION

A. Emergency Rescue Operation:

1. Provide a battery power source to send the elevator to the lowest landing. After the elevator has leveled at the lowest landing, provide power to open the car and hoistway doors automatically. After a predetermined time, the doors shall close. Power shall stay applied to the door open button to reopen the doors from the inside of the elevator. The elevator shall remain shut down at the bottom landing until normal power is restored. Install a sign on the controller indicating that power is applied to emergency rescue operator and door operator during loss of normal power.
2. Provide micro-switch in main line disconnect to interrupt the battery power source when main line disconnect is switched to off.

2.9 INDEPENDENT SERVICE

A. Provide an INDEPENDENT SERVICE key switch on the face of the main car operating panel that shall have its positions marked "ON" and "OFF". When the switch is in the "ON" position, the car shall respond only to calls registered on its car dispatch buttons and shall bypass all calls registered on landing push buttons. The car shall start when a car call is registered, car call button or door close button is pressed, car and hoistway doors are closed, and interlock circuits are made. When switch is returned to "OFF" position, normal service shall be resumed.

2.10 PUMP, MOTOR, AND VALVE ASSEMBLY

A. Provide new pump assembly for the control of the elevator self-contained in a unit fabricated of structural steel. The unit shall consist of a hydraulic fluid pump, AC motor, oil control valves, muffler, piping, and fittings.

B. Control valves shall be electronically controlled. Hydraulic fluid flow shall be controlled to insure speed variation of not more than five (5) percent under all load conditions in either direction of travel. Locate the manual lowering valve, easily accessible, properly identified, and not concealed within the storage tank. Mark the operating handle in red.

C. Pump shall be designed for hydraulic elevator service, having a steady discharge without pulsation to give smooth and quiet operation. Pump output shall be capable of lifting elevator car with rated capacity, with a speed variation of no more than five (5) percent between no load and full load. Hydraulic fluid by-pass shall discharge directly into storage tank.

D. Provide motor specifically designed for elevator service, synchronous speed of 1800 RPM, not to exceed nameplate full load current by more than 10%, and rated 120 starts per hour without exceeding a rise of 40 degrees C.

1. Basis-of-Design Horse Power: 40 HP.

a. If a different motor size is selected by the contractor, the contractor is responsible for providing revised electrical drawings and all costs associated with any changes in electric or other utilities associated with elevator, including HVAC for machine room if requirements for provided machine are different than those designed around.

E. Provide isolation pads to prevent transmission of pump and motor vibration to the building.

F. Install blowout-proof, non-hammering, oil-hydraulic muffler in the hydraulic fluid supply pressure line near power unit in machine room. Design muffler to reduce to a minimum any pulsation or noises that may be transmitted through the hydraulic fluid into the hoistway.

2.11 HYDRAULIC SYSTEM

A. Construct the storage tank of sheet steel, welded construction, and a steel cover with means for filling, a minimum one-inch protected vent opening, and a valve drain connection. Tank shall be sized to pass through machine room door as shown on drawings. Provide marked gauge to monitor hydraulic fluid level. Tank shall be sized to hold volume of hydraulic fluid required to lift elevator to stop ring, plus a reserve of not less than ten gallons. Provide a baffle in the bottom of the tank to prevent entry of any sediment or foreign particles into hydraulic system. Baffle shall also minimize aeration of hydraulic fluid. Permissible minimum hydraulic fluid level shall be clearly indicated. Hydraulic fluid shall be of good grade to assure free flow when cool and have minimum flash point of 380-400 degrees F. Provide initial supply of hydraulic fluid for operation of elevator.

1. Provide a means to maintain the fluid viscosity in the reservoir, pump, and control valve at a recommended operating temperature.
2. Provide a data plate on the tank frame indicating the characteristics of the hydraulic fluid used.

B. Furnish and install connections between the storage tank, pump, muffler, operating valves, and cylinder complete with necessary valves, pipe supports, and fittings. Pipe shall be minimum

schedule 80 steel with threaded, flanged, or welded mechanical couplings. Size of pipe and couplings between cylinder and pumping unit shall be such that fluid pressure loss is limited to 10 percent.

C. Hydraulic system working pressure shall not exceed 500 psi under any load condition. Do not subject valves, piping, and fittings to working pressure greater than those recommended by the manufacturer.

D. Support all horizontal piping. Place hangers or supports within 300 mm (12 in.) on each side of every change of direction of pipe line and space supports not over 3.0 m (10 ft) apart. Secure vertical runs properly with iron clamps at sufficiently close intervals to carry weight of pipe and contents. Provide supports under pipe to floor.

1. Provide all piping from machine room to hoistway, including necessary supports or hangers. If remote piping is underground or in damp inaccessible areas, install hydraulic piping thru PVC sleeve.

E. Install pipe sleeves where pipes pass through walls or floors. After installation of piping, equip the sleeves with snug fitting inner liner of fire rated insulation.

F. Provide an automatic shut-off valve in the oil supply line at the cylinder inlet. Activate the automatic shut-off valve when there is more than a ten percent increase in high speed in the down direction. When activated, this device shall immediately stop the descent of the elevator and hold the elevator. The exposed adjustments of the automatic shut-off valve shall have their means of adjustment sealed after being set to their correct position.

G. Provide external tank shut-off valve to isolate hydraulic fluid during maintenance operations.

H. Provide shut-off valves in the pit near the cylinder and in the machine room capable of withstanding 150 percent of design operating pressure. Each manual valve shall have an attached handle.

I. Components of the hydraulic system shall be factory certified to withstand pressure equal to twice the calculated working pressure.

2.12 HYDRAULIC PLUNGER ASSEMBLY

A. Reuse existing plunger and casing.

2.13 CAR BUFFERS

A. Retain existing spring buffers.

2.14 GUIDE RAILS, SUPPORTS, AND FASTENINGS

A. Reuse existing. Clean, replace missing bolts, and tighten as needed.

2.15 NORMAL STOPPING DEVICES

A. Mount new terminal slowdown switches and direction limit switches on the elevator or in hoistway to reduce speed and bring car to an automatic stop at the terminal landings.

1. Switches shall function with any load up to and including 100 percent of rated elevator capacity at any speed obtained in normal operation.

2. Switches, when opened, shall permit operation of elevator in reverse direction of travel.

2.16 CROSSHEAD DATA PLATE AND CODE DATA PLATE

A. Permanently attach a non-corrosive metal Data Plate to car crosshead.

B. Permanently attach a Code Data Plate, in plain view, to the controller.

2.17 CARTOP OPERATING DEVICE

A. Provide a new cartop operating device.

B. The device shall be activated by a toggle switch mounted in the device. The switch shall be clearly marked "INSPECTION" and "NORMAL" on the faceplate, with 6 mm (.25 in.) letters.

C. Movement of the elevator shall be accomplished by the continuous pressure on a direction button and a safety button.

D. Provide an emergency stop switch, push to stop/pull to run.

E. Provide permanent identification for the operation of all components in the device.

F. The device shall be permanently attached to the elevator crosshead on the side of the elevator nearest to the hoistway doors used for accessing the top of the car.

2.18 CAR LEVELING DEVICE

A. Car shall be equipped with a new two-way leveling device to automatically bring the car to within 3 mm (.125 in.) of exact level with the landing for which a stop is initiated regardless of load in car or direction of travel.

B. If the car stops short or travels beyond the floor, the leveling device, within its zone shall automatically correct this condition and maintain the car within 3 mm (.125 in.) of level with the floor landing regardless of the load carried.

2.19 EMERGENCY STOP SWITCHES

A. Provide an emergency stop switch, push to stop/pull to run, for the top-of-car device, pit, machine spaces, service panel and firefighter’s control panel inside the elevator. Mount stop switches in the pit adjacent to pit access door, at top of the pit ladder 1200 mm (48 in.) above the bottom landing sill and 1200 mm (48 in.) above the pit floor adjacent to the pit ladder.

B. Each stop switch shall be red in color and shall have "STOP" and "RUN" positions legibly and indelibly identified.

2.20 MAIN CAR OPERATING PANEL

A. Provide new main car operating panel in the car enclosure on the front return panel for elevator. The top floor car call push button shall not be more than 1200 mm (48 in.) above the finished floor. Car call push buttons and indicator lights shall be LED illuminated, round with a minimum diameter of 25 mm (1 in.). Each button shall contain an integral registration LED white light which shall illuminate upon registration of a call and shall extinguish when that call is answered.

B. One-piece hinged swing return panel shall have the firefighter’s service panel recessed into the upper section and the service operation panel recessed into the lower section fitted with hinged doors. Doors shall have concealed hinges, be in the same front plane as the faceplate and fitted with cylinder type key operated locks. Secure the faceplate with stainless steel tamperproof screws.

C. All terminology and tactile symbols on the faceplate shall be on square or rectangular plates recessed into the faceplate with its surface flush with the surface of the faceplate. Use 6 mm (.25 in.) letters to identify all devices in the faceplate. The handicapped markings with contrasting

background shall be 12.5 mm (.50 in.) high raised .075 mm (.030 in.) on the plate. Surface mounted plates are not acceptable.

D. The upper section shall contain the following items in order listed from top to bottom:

1. Elevator number, 12.5 mm (.50 in.) high with black paint for contrast.
2. Capacity plate information with black paint for contrast with freight loading class and number of passengers allowed.
3. LED illuminated digital car position indicator.
4. Emergency car lighting system consisting of a rechargeable battery, charger, controls, and LED illuminated light fixture. The system shall automatically provide emergency light in the car upon failure or interruption of the normal car lighting service, and function irrespective of the position of the light control switch in the car. The system shall maintain a minimum illumination of 1.0 foot-candle when measured 1200 mm (48 in.) above the car floor and approximately 300 mm (12 in.) in front of the car operating panel, for not less than four (4) hours.
5. Firefighter's Emergency Operation Panel shall be 1650 mm (66 in.) minimum to 1800 mm (72 in.) maximum to the top of the panel above finished floor.
6. Firefighter's Emergency Indicator Light shall be round with a minimum diameter of 25 mm (1 in.).
7. Key operated Independent Service Switch on the face of panel or switch inside service panel.
8. Complete set of round car call push buttons, minimum diameter of 25 mm (1 in.), and LED white light illuminated, corresponding to the floors served. Car call buttons shall be legibly and indelibly identified by a floor number and/or letter not less than 12.5 mm (.50 in.) high in the face of the call button.
9. Door Open and Door Close buttons shall be located below the car call buttons. They shall have "OPEN" and "CLOSE" legibly and indelibly identified by letters in the face of the respective button. The Door Open button shall be located closest to the door jamb.
10. Red Emergency Alarm button that shall be located below the car operating buttons. Mount the emergency alarm button not lower than 875 mm (35 in.) above the finished floor. It shall be connected to audible signaling devices. Provide audible signaling devices including the necessary wiring.
11. Emergency Help push button shall activate two-way communications by Auto Dial telephone system that is compatible with the owner's telephone system. Help button shall be LED white light illuminated and flash when call is acknowledged. Legibly and indelibly label the button "HELP" in the face of the button with 12.5 mm (.50 in.) high letters.

E. The service operation panel, in the lower section shall contain the following items:

1. Light switch labeled "LIGHTS" for controlling interior car lighting with its two positions marked "ON" and "OFF".
2. Inspection switch that will disconnect normal operation and activate hoistway access switches at terminal landings. Switch shall be labeled "ACCESS ENABLE" with its two positions marked "ON" and "OFF".
3. Three position switch labeled "FAN" with its positions marked "HIGH", "LOW" and "OFF" for controlling car ventilating blower.
4. Two position, spring return, toggle switch or push button to test the emergency light and alarm device. It shall be labeled "TEST EMERGENCY LIGHT AND ALARM".
5. Independent service switch labeled "ON" AND "OFF" or key switch on face of panel.

2.21 CAR POSITION INDICATOR

A. Provide an alpha-numeric digital car position indicator in the main car operating panel, consisting of numerals and arrows not less than 63 mm (2.5 in.) high, to indicate position of car and direction of car travel. Locate position indicator at the top of the main car operating panel, illuminated by light emitting diodes.

2.22 AUTO DIAL TELEPHONE SYSTEM

A. Furnish and install a complete ADA compliant auto dial telephone that is compatible with the Owner's telephone system.

B. Provide a two-way communication device in the car with automatic dialing, tracking and recall features with shielded wiring to car controller in machine room. Provide dialer with automatic rollover capability with two numbers.

C. "HELP" button shall illuminate and flash when call is acknowledged. Button shall match floor push button design.

D. Provide "HELP" button tactile symbol signage and Braille adjacent to button mounted integral with car operating panels.

E. The auto dial system may be in the main car operating panel. The speaker and unit shall be mounted on the backside of the perforated stainless-steel plate cover.

F. If the operator ends the call, the passenger shall be able to redial the telephone immediately.

2.23 CORRIDOR OPERATING DEVICES

A. Fabricate faceplates for elevator operating and signal devices from not less than 3 mm (.125 in.) thick flat stainless steel with all edges beveled 15 degrees.

B. Corridor push button faceplates shall be sized to cover existing openings in the walls. The centerline of the landing push buttons shall be 1050 mm (42 in.) above the corridor floor.

C. Elevator Corridor Call Station Pictograph shall be engraved in the faceplate.

D. Fasten all car and corridor operating device and signal device faceplates with stainless steel tamperproof screws.

E. All terminology and tactile symbols on the faceplate shall be raised .030 inch with contrasting background, on square or rectangular plates recessed into the faceplate with its surface flush with the surface of the faceplate. The handicapped markings with contrasting background shall be 12mm (0.5 in.) high raised .030 inch on the plate, square or rectangular. Use 6 mm (.25 in.) letters to identify all other devices in the faceplate. Surface mounted plates are not acceptable.

F. Each button shall contain an integral registration LED white light which shall illuminate upon registration of a call and shall extinguish when that call is answered.

G. The direction of each button shall be legibly and indelibly identified by arrows not less than 12 mm (.50 in.) high in the face of each button. Provide a corresponding Braille plate on the left side of each button.

H. Landing push buttons shall not re-open the doors while the car and hoistway doors are closing at that floor, the call shall be registered for the next available elevator. Calls registered shall be canceled if closing doors are re-opened by means of "DOOR OPEN" button or infrared curtain unit.

I. Provide fire recall instruction, communication failure light, audible enunciator, and reset key switch in the fixture at the designated main floor.

J. Submit design of hall pushbutton fixtures for approval.

2.24 HOISTWAY ACCESS

A. Provide new hoistway access switches for elevator at top terminal landing to permit access to top of car, and at bottom terminal landing to permit access to pit. Elevators with side slide doors, mount the access key switch 180 cm (6 ft) above the corridor floor in the wall next to the strike jamb.

B. Exposed portion of each access switch or its faceplate shall have legible, indelible legends to indicate "UP", "DOWN", and "OFF" positions.

C. Each access switch shall be a constant pressure cylinder type lock having not less than five pins or five stainless steel disc combination with key removable only when switch is in the "OFF" position.

D. Arrange the hoistway switch to initiate and maintain movement of the car. When the elevator is operated in the down direction from the top terminal landing, limit the zone of travel to a distance not greater than the top of the car crosshead level with the top floor. Submit design and location of access switches for approval.

2.25 HOISTWAY ENTRANCES: PASSENGER ELEVATOR

A. Clean existing entrance frames.

B. Clean and reuse existing hoistway sills, hanger supports, strut angles, fascia plates and toe guards.

C. Replace all damaged or missing dust covers.

D. Clean existing hoistway doors and prepare for new operating equipment.

1. Door operating equipment shall be manufactured by GAL, no substitutions.

E. Hang doors on two-point suspension hangers having sealed ball-bearing sheaves not less than 75 mm (3 in.) in diameter, with non-metallic sound-reducing tires. Equip hangers with adjustable ball-bearing rollers to take upward thrust of panels. Provide two non-metallic door gibs on each door panel and a separate fire gib. Gibs shall be replaceable without removing of door panel. One door panel for each entrance shall bear a Underwriters' label, or other labels may be furnished provided they are based on fire test reports and factory inspection procedures acceptable to the Owner. Fasten stainless steel sight guard of 14-gauge metal, extending full height of panel, to leading edge of fast speed panel of two-speed doors.

F. Provide new interlocks, gibs, separate fire gibs, door rollers, door locks, drive roller assemblies and closers.

G. Reuse Braille plates on both sides of door frame entrances located 1500 mm (60 in.) to center above finished floor. Replace damaged or missing Braille plates.

H. Equip hoistway entrance with a new electrical/mechanical interlock, functioning as hoistway unit system, to prevent operation of car until all hoistway doors are locked in closed position.

I. Wiring installed from the hoistway riser to each door interlock shall be NEC type SF-2 or equivalent.

2.26 CAR GUIDES

A. Refurbish existing car guide assemblies.

2.27 CAR FRAME: PASSENGER/SERVICE ELEVATORS

A. Reuse existing car frame. Tighten bolts and replace missing bolts.

2.28 CAR PLATFORM: PASSENGER ELEVATORS

A. Reuse existing car platform and update or replace platform guard as required to meet current elevator code. Tighten bolts and replace missing bolts.

B. Balance car front to back and side to side. Provide balancing frame and weights, properly located, to achieve the required true balance.

C. Provide a bonding wire between frame and platform.

2.29 CAR ENCLOSURE: PASSENGER ELEVATORS

A. Reuse existing car enclosure.

B. Examine fasteners for existing care enclosure and repair or replace as needed for secure attachment.

C. Provide car top railings as required by code.

D. Provide a hinged top emergency exit cover. Exit shall be unobstructed when open and shall have mechanical stops on the cover. Provide an exit switch to prevent operation of the elevator when the emergency exit is open.

E. Provide duplex, GFCI protected receptacle in car. Locate flush-mounted receptacle on the centerline of the main car operating panel, 150 mm (6 in.) above the car floor.

F. Lighting for passenger elevators:

1. Provide stainless steel panels andhanging ceiling frame. Construct frame of .125 in. x 1.50 in. x 1.50 in. “T” and “L” sections divide ceiling into six panels.
2. Provide LED illuminated car light fixtures above the ceiling panels. Maintain a minimum light level of 50-foot candles at 914 mm (36 in.) above the finished floor.

G. Remove existing blower and provide a new blower unit arranged to exhaust through an opening in the canopy. Provide a stainless or chrome plated fan grill on the interior side of the opening. Provide screening over intake and exhaust end of blower. Provide 2-speed fan, with rated air displacement of 250 cfm and 400 cfm at respective speeds. Mount fan on top of car with rubber isolation to prevent transmission of vibration to car structure. Provide a 3-position switch to control the unit in the service panel.

H. Provide car enclosure with one handrail with centerline at 34 in**.** above the car floor.

1. Locate handrails 1.50 in. from cab wall. Install handrails on rear wall. Conceal all handrail fastenings. Handrails shall be removable from inside the car enclosure.

I. Reuse existing car doors.

1. Provide all new rollers, mounting hardware, and operating mechanisms.

OPERATORS: PASSENGER ELEVATORS

J. Provide a new high-speed heavy-duty door operator to automatically open the car and hoistway doors simultaneously when the car is level with the floor, and automatically close the doors simultaneously at the expiration of the door-open time. Provide solid-state door control with closed loop circuitry to constantly monitor and automatically adjust door operation based upon velocity, position, and motor current. Motor shall be of the high-internal resistance type, capable of withstanding high currents resulting from stall without damage to the motor. The door operator shall open the car door and hoistway door simultaneously, at a speed of .750 m (2.5 ft) per second. The closing speed of the doors shall be .3 m (1 ft) per second. A reversal of direction of the doors from the closing to opening operation, whether initiated by obstruction of the infrared curtain or the door "OPEN" button, shall be accomplished within 38 mm (1.5 in.) maximum of door movement. Emphasis is placed on obtaining quiet interlock and door operation; smooth, fast, dynamic braking for door reversals, stopping of the door reversal, and stopping of the doors at extremes of travel. Construct all levers and drive arms operating the doors, of heavy steel members, and all pivot points shall have ball or roller bearings.

K. Provide infrared curtain unit. The device shall cause the car and hoistway doors to reverse automatically to the fully-open position should the unit be actuated while the doors are closing. Unit shall function when the doors are not closed, irrespective of all other operating features except firefighter’s service.

L. Should the doors be prevented from closing for more than a predetermined adjustable interval of 20 to 60 seconds by operation of the curtain unit, the doors shall stay open, the audio voice message and a buzzer located on the car shall sound only on automatic operation. Do not provide door nudging.

1. If an obstruction of the doors should not activate the photo-electric door control device and prevent the doors from closing for more than a predetermined adjustable interval of 15 to 30 seconds, the doors shall reverse to the fully open position and remain open until the “Door Close” button re-establishes the closing cycle.

M. Provide door "OPEN" and "CLOSE" buttons. When the door "OPEN" button is pressed and held, the doors, if in the open position, shall remain open and if the doors are closing, they shall stop, reverse and re-open. Momentary pressure of the door "CLOSE" button shall initiate the closing of the doors prior to the expiration of the normal door open time.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine work of other trades on which the work of this section depends. Report defects to the Architect in writing which may affect the work of the elevator contractor.

B. Examine elevator hoistway openings for plumb, level, in line, and that elevator pit is proper size, waterproofed and drained with necessary access door, and ladder.

C. Before fabrication, take necessary job site measurements, and verify where work is governed by other trades. Check measurement of space for equipment and means of access for installation and operation. Obtain dimensions from site for preparation of shop drawings.

3.2 ARRANGEMENT OF EQUIPMENT

A. Arrange equipment in machine room so that major equipment components can be removed for repair or replacement without dismantling or removing other equipment in the same machine room. Locate controller near and visible to its respective hoisting machine.

3.3 WORKMANSHIP AND PROTECTION

A. Installations shall be performed by Certified Elevator Mechanics and Apprentices to best possible

industry standards. Details of the installation shall be mechanically and electrically correct. Materials and equipment shall be new and without imperfections.

B. Recesses, cutouts, slots, holes, patching, grouting, refinishing to accommodate installation of equipment shall be included in the Contractor's work. All new holes in concrete shall be core drilled.

C. Structural members shall not be cut or altered. Work in place that is damaged or defaced shall be restored equal to original new condition.

D. Finished work shall be straight, plumb, level, and square with smooth surfaces and lines. All machinery and equipment shall be protected against dirt, water, or mechanical injury. At completion, all work shall be thoroughly cleaned and delivered in perfect unblemished condition.

E. Sleeves for conduit and other small holes shall project 50 mm (2 in.) above concrete slabs.

F. Exposed gears, sprockets, and sheaves shall be guarded from accidental contact.

3.4 CLEANING

A. Clean machine room and equipment.

B. Perform hoistway clean down.

C. Prior to final acceptance, remove protective covering from finished or ornamental surfaces. Clean and polish surfaces regarding type of material.

3.5 PAINTING AND FINISHING

A. All equipment, except specified as architectural finish, shall be painted one coat of approved color, conforming to manufacturer's standard.

B. New machinery shall be factory painted with manufacturer's standard finish and color.

C. Stencil or apply decal floor designations not less than 100 mm (4 in.) high on hoistway doors, fascia or walls within door restrictor areas. The color of paint used shall contrast with the color of the surfaces to which it is applied.

D. Elevator pump/motor machine, controller, main line switch/shunt trip circuit breaker, bolster channel, and cross head of car shall be identified by 100 mm (4 in.) high numerals and letters located as directed. Numerals shall contrast with surrounding color and shall be stenciled or decaled.

3.6 PRE-TESTS AND TESTS

A. Pre-test the elevators and related equipment in the presence of the Owner for proper operation before requesting final inspection. Conduct final inspection at other than normal working hours, if required by Contracting Officer.

1. Owner shall furnish electric power including necessary current for starting, testing, and operating machinery of each elevator.
2. Contractor shall furnish the following test instruments and materials on-site and at the designated time of inspection: properly marked certified test weights, voltmeter, amp probe, thermometers, direct reading tachometer, megohm meter, vibration meter, sound meter, light meter, stop watch, and a means of two-way communication.

B. Inspection of workmanship, equipment furnished, and installation for compliance with specification.

C. Speed Test: The actual speed of the elevator shall be determined in both directions of travel with full contract load and no load in the elevator. Speed shall be determined by certified tachometer. The actual measured speed of the elevator with all loads in either direction shall be within five (5) percent of specified rated speed. Full speed runs shall be quiet and free from vibration and sway.

D. Car Leveling Test: Elevator car leveling devices shall be tested for accuracy of leveling at all floors with no load in car and with contract load in car in both directions of travel. Accuracy of floor level shall be within plus or minus 3 mm (.125 in.) of level with any landing floor for which the stop has been initiated regardless of load in car or direction of travel. The car leveling device shall automatically correct over travel as well as under travel and shall maintain the car floor within plus or minus 3 mm (.125 in.) of level with the landing floor regardless of change in load.

E. Overload Devices: Test all overload current protection devices in the system at final inspection.

F. Limit Stops:

1. The position of the car when stopped by each of the normal limit stops with no load and with contract load in the car shall be accurately measured.
2. Final position of the elevator relative to the terminal landings shall be determined when the elevator has been stopped by the final limits. The lower limit stop shall be made with contract load in the elevator. Elevator shall be operated at inspection speed for both tests. Normal limit stopping devices shall be inoperative for the tests.

G. Working Pressure: Verify working pressure of the hydraulic system by pressure gauge placed in the system line. Take readings with no load and full load in car.

H. Test automatic shut-off valve for proper operation.

I. Operating and Signal System: The elevator shall be operated by the operating devices provided and the operation signals and automatic floor leveling shall function in accordance with requirements specified. Starting, stopping and leveling shall be smooth and comfortable without appreciable steps of acceleration or deceleration.

J. Performance of the Elevator supervisory system shall be witnessed and approved by the Owner.

K. Evidence of malfunction in any tested system or parts of equipment that occurs during the testing shall be corrected, repaired, or replaced at no additional cost to the Owner, and the test repeated.

L. If equipment fails test requirements and a re-inspection is required, the Contractor shall be responsible for the cost of re-inspection; salaries, transportation expenses, and per-diem expenses incurred by the representative of the Owner.

3.7 INSTRUCTION TO OWNER PERSONNEL

A. Provide competent instruction to Owner’s personnel regarding the operation of equipment and accessories installed under this contract, for a period equal to one eight-hour work day. Instruction shall commence after completion of all work and at the time and place directed by the Owner.

B. Written instructions in triplicate relative to care, adjustments and operation of all equipment and accessories shall be furnished and delivered to the Owner in independently bound folders. digital recordings will also be acceptable. Written instructions shall include correct and legible wiring diagrams, nomenclature sheet of all electrical apparatus including location of each device, complete and comprehensive sequence of operation, complete replacement parts list with descriptive literature, and identification and diagrammatic cuts of equipment and parts. Information shall also include electrical operation characteristics of all circuits, relays, timers, and electronic devices, as well as rpm values and related characteristics for all rotating equipment.

C. Provide supplementary instruction for any new equipment that may become necessary because of changes, modifications or replacement of equipment or operation under requirements of paragraph entitled "Warranty of Construction".

3.8 INSPECTIONS AND SERVICE: GUARANTEE PERIOD OF SERVICE

A. Furnish complete inspection and maintenance service on entire elevator installation for a period of one (1) year after completion and acceptance of all the elevators in this specification by the Owner. This maintenance service shall run concurrently with the warranty. Maintenance work shall be performed by Certified Elevator Mechanic and Apprentices employed and supervised by

the company that is providing guaranteed period of service on the elevator equipment specified herein.

B. This contract will cover full maintenance including emergency call back service, inspections and servicing the elevators listed in the schedule of elevator. The Elevator Contractor shall be required to perform the following:

1. Systematic examination of equipment.
2. During each maintenance visit the Elevator Contractor shall clean, lubricate, adjust, repair and replace all parts as necessary to keep the equipment in first class condition and proper working order.
3. Furnishing all lubricant, cleaning materials, parts and tools necessary to perform the work required. Lubricants shall be only those products recommended by the manufacturer of the equipment.
4. As required, motors, controllers, selectors, leveling devices, operating devices, switches on cars and in hoistways, hoistway doors and car doors or gate operating device, interlock contacts, guide shoes, guide rails, car door sills, hangers for doors, car doors or gates, and signal system shall be cleaned, lubricated and adjusted.
5. Guide rails and bottom of platforms shall be cleaned every three months. Car tops and machine room floors shall be cleaned. Accumulated rubbish shall be removed from the pits. A general cleaning of the entire installation including all machine room equipment and hoistway equipment shall be accomplished quarterly. Cleaning supplies and vacuum cleaner shall be furnished by the Contractor.
6. Maintain the performance standards set forth in this specification.
7. The operational system shall be maintained to the standards specified hereinafter including any changes or adjustments required to meet varying conditions of occupancy.
8. Maintain smooth starting and stopping and accurate leveling always.

C. Maintenance service shall not include the performance of work required because of improper use, accidents, and negligence for which the Elevator Contractor is not directly responsible.

D. Provide 24-hour 365 days per year emergency call-back service that shall consist of promptly responding to calls within two hours for emergency service should a shutdown or emergency develop between regular examinations. Overtime emergency call-back service shall be limited to minor adjustments and repairs required to protect the immediate safety of the equipment and persons in and about the elevator.

E. Service and emergency personnel shall report to the Owner upon arrival at the building and again upon completion of the required work. A copy of the work ticket containing a complete description of the work performed shall be given to the Owner.

F. The Elevator Contractor shall maintain a log book in the machine room. The log shall list the date and time of all monthly examinations and all trouble calls. Each trouble call shall be fully described including the nature of the call, necessary correction performed, or parts replaced.

G. Written “Maintenance Control Program” shall be in place to maintain the equipment in compliance with ASME A17.1.

END OF SECTION 14 24 10

SECTION 32 35 00 – SITE SCREENING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pre-formed composite wood panel for screening or buffering trash enclosures.

2. Aluminum support framing for direct attachment of screen support columns are provided for attachment to concrete pad, piers, or footings provided by others.

3. Operable gates for access through screens.

1.3 REFERENCES

A. American Society for Testing and Materials: Standard Specifications for

1. ASTM B 221-13 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire Profiles, and Tubes.

B. The Aluminum Association, Inc.

1. AA ADM-1516166 (1994) - Aluminum Design Manual

C. American Society of Civil Engineers.

1. ASCE 7-95 - Minimum Design Loads for Buildings and Other Structures.

1.4 COORDINATION

A. Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.

1. Request information on sizes and options required from the Contractor.

B. Submit shop drawings to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication.

C. Confirm size, type, and location of supporting construction as adequate to resist column supports.

1.5 SYSTEM DESCRIPTION

A. Design Criteria: Manufacturer is responsible for the structural design of all materials, assembly and attachments to resist snow, wind, suction and uplift loading at any point without damage or permanent set.

1.6 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's catalog data, detail sheets, specification and other data sufficient to indicate compliance with these specifications.

B. Shop Drawings: Indicate layouts heights, component connection details, and details of interface with adjacent construction.

C. Samples:

1. Samples of Materials: Thermoplastic panels, Plankwall™, Nature Screen ™, Metal Series
2. Color Selection: Full range of colors available (including custom options) for Architect's selection.

D. Certification: Manufacturer's Certificate of Compliance certifying that panels supplied meet or exceed requirements specified.

E. Closeout Submittals: Warranty documents, issued and executed by manufacturer, countersigned by Contractor.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of building authorities having jurisdiction in Project location.

B. Manufacturer Qualifications: Minimum five (5) years documented experience producing systems specified in this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage and Handling: Protect materials and finishes during handling and installation to prevent damage.

1.9 PROJECT CONDITIONS

A. Field Measurements: Take measurements of supporting paving, footings, or piers. Indicate measurements on shop drawings fully documenting any field condition that may interfere with the screen system installation.

1.10 WARRANTY

A. If any part of the screen system fails because of a manufacturing defect within one year from the date of substantial completion, the manufacturer will furnish without charge the required replacement part(s). Any local transportation, related service labor or diagnostic call charges are not included.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide product by the following:

1. Covrit Gates and Screening System by CityScapes International Inc, 4200 Lyman Ct. Hilliard, OH 43026
2. Architect approved equal

2.2 MATERIALS

A. Plankwall™ ,PVC (Polyvinyl Chloride), AcrylicCap™ ABS (Acrylic Butylene Styrene), Metal Series (Coated steel sheets with foam core), Classic Brick (Polyurethane) Ipe Brazilian Hardwood (100% IPE Brazilian Hardwood) , ToughGate (Gates) are comprised of natural wood, or PVC (Polyvinyl Chloride) sheets.

1. Minimum thickness: 3/16 inch (4.7625 mm).

B. Framing: Aluminum Plate, Shapes and Bar: ASTM B 221, alloy6005-T5, 6061-T5 or 6063-T5.

C. Threaded Fasteners: All screws, bolts, nut, and washers shall be Stainless steel.

1. Corner assembly fasteners shall be #10-16 x stainless steel TEK screws.
2. Provide lock washer or other locking device at all bolted connections.

2.3 FABRICATION

A. Provide factory-formed panel systems with continuous interlocking panel connections and indicated or necessary components: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.

B. Fabricate products to the following configurations:

1. Panel Style: TBD by Architect
2. ToughGate Gate Style: TBD by Architect
3. Panel and Gate Height: As indicated on Drawings
4. Gate Width: As indicated on Drawings
5. Decorative Top Rail Trim Profile: Boxed
6. Column Cap Style: Pyramid
7. Dumpster Layout: As indicated on Drawings

C. Trim and Closures: Fabricated and finished with the manufacturers standard coating system, unless shown otherwise on drawings.

D. Framing: Fabricate and assemble components in largest practical sizes, for delivery to the site.
1. Construct corner assemblies to required shape with joints tightly fitted.
2. Supply components required for anchorage of framing. Fabricate anchors and related components of material and finish as required, or as specifically noted.

E. Gate Hardware: TBD selected by Architect in submittal.

F. Aluminum Framing: Mill finish.

G. Panel Coating: Manufacturer's standard coating system, factory-applied.
1. Color: Selected from full range of manufacturer's standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installer's Examination: Examine conditions under which construction activities of this section are to be performed.

1. Submit written notification to Architect and Screen manufacturer if such conditions are unacceptable.
2. Beginning erection constitutes installer's acceptance of conditions.

3.2 METHODS

A. Model HP70 (460) Folding Wall Aluminum Ladder Standard Assembly

B. Establish distance from the floor to the underside of the roof hatch cover, then locate the mounting bracket centerline 15" (381 mm) for ladders under 11' (3.4 m) or 18" (457 mm) for ladders 11' (3.4 m) and over below the underside of the roof hatch cover. Check clear floor space required in unfolded position, then install the ladder at 70 angular degrees.

C. Complete installation recommendations for all product models are available from the manufacturer.

3.3 INSTALLATION

A. Install units in accordance with the manufacturer's instructions and approved shop drawings. Keep perimeter lines straight, plumb, and level. Provide brackets, anchors, and accessories necessary for a complete installation.

B. Fasten structural supports to paving, footings, or piers at spacing as indicated on approved shop drawings.

C. Insert thermoplastic panels into structural supports, except where fixed attachment points are indicated. Butt thermoplastic panels to adjacent panels for uniform fit. Fasten fixed panels in accordance with the shop drawings.

D. Metal Separation: Where aluminum materials would contact dissimilar materials, insert rubber grommets at attachment points, thus eliminating where dissimilar metals would otherwise be in contact.

E. Do not cut or abrade finishes which cannot be restored. Return items with such finishes to shop for required alterations.

3.4 ERECTION TOLERANCES

A. Maximum misalignment from true position: ¼ inch (6.35 mm).

3.5 CLEANING AND PROTECTION

A. Remove all protective masking from material immediately after installation.

B. Protection:

1. Ensure that finishes and structure of installed systems are not damaged by subsequent construction activities.
2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.

C. Prior to Substantial Completion: Remove dust or other foreign matter from component surfaces; clean finishes in accordance with manufacturer's instructions.

1. Clean units in accordance with the manufacturer's instructions.

END OF SECTION 32 35 00

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quality requirements
2. Coordination Procedures
3. Testing
4. Inspections
5. Motors.
6. Alignment guides and anchors.
7. Sleeves.
8. Grout and sealants.
9. Thermometers, filled system.
10. Thermometers, liquid in glass.
11. Duct-thermometer mounting brackets.
12. Thermowells.
13. Pressure gauges, dial type.
14. Gauge attachments.

1.2 DEFINITIONS

A. Existing To Remain (ETR): Existing that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Refer to procedures and requirements for submittals in Division 1 specifications

B. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.
    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

C. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing

connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

D. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Provide work that is complete in every respect, tested and ready for operation, with equipment, components, materials and installation of the highest quality and conforming to accepted practices and standards of all mechanical trades on the project

B. Provide systems, components, equipment and materials in compliance with Ohio Mechanical Code 2017 and requirements of the Authority Having Jurisdiction (ASJ).

C. All equipment, components and appliances provided for the project shall bear the label of an approved testing agency, and installed in accordance with the manufacturer’s instructions and recommendations.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

A. Mechanical contractor shall take responsibility for coordination of HVAC system demolition and installation with contractors of all other trades before beginning any demolition or installation work; as well as existing building elements and conditions.

1. Consult all contract drawings of all trades as may affect work of the mechanical scope.
2. Notify the construction manager immediately of any changes in equipment, locations, or conflicts which may impact a work of other contractors
3. Review all existing and new equipment electrical requirements, before ordering any equipment, and advise structure manager immediately of any changes in design or installation required for proper electrical service and wiring of equipment.

B. Mechanical contractor shall initiate development of coordination drawings and meet with all trades to facilitate a coordination drawings generation process to demonstrate multiple system coordination of all inter-disciplinary installations on the project. The process shall be conducted using electronic drafting software (AutoDesk) or BIM software, at contractor's discretion.

1. Mechanical contractor shall begin with preliminary coordination drawings which include all mechanical equipment and elements, and plan and elevation views, coordinating with building elements such as floor to floor elevations, ceiling heights, chases, shafts, roofs and exterior elevations.
2. A preliminary coordination drawings will be provided to all other trades for their input of their equipment and installed systems, materials.
3. Throughout the process, any conflicts shall be identified and reported to the construction manager and affected trades.
4. Mechanical contractor and affected trades shall meet to develop resolution and details for such conflicts; updating the coordination drawings accordingly.
5. Completed preliminary coordination drawings shall be reviewed and accepted by all contractors before submitting to the construction manager for final review and acceptance. Any changes necessary to the contract documents shall be approved first by the owner.
6. The coordination drawing process shall be started, managed and completed in keeping with the overall project schedule.
7. Equipment orders, material orders, installation, shall not commence until the coordination process is completed; unless otherwise approved by the construction manager

C. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or other specification sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Rotor: Random-wound, squirrel cage.
6. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
7. Temperature Rise: Match insulation rating.
8. Insulation: Class F.
9. Code Letter Designation:
    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.
10. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
    e. Shaft grounding rings for grounding of currents generated along shaft motor by voltage potential that can be generated by imbalances by application of variable-speed controller electronics, protecting motor bearings.
3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Permanently pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 208 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. Circuit board, or digital speed controller/LED display.
4. Building Automation System Interface: Via AC voltage signal, DC voltage signal, or Digital Serial Interface (DSI).

PART 3 - EXECUTION

3.1 INSPECTIONS

A. Provide inspections of installed work in accordance with the requirements outlined in the Division I specifications

B. Contractor shall notify the construction manager minimum of 48 hours in advance of any inspections, such that there is opportunity to witness inspections. Inspections performed without may be required to be repeated, at construction manager's discretion.

C. Do not insulate, cover, or otherwise conceal equipment items, components or materials to be inspected.

D. Submit all inspection results and reports to the Construction manager for review and acceptance promptly upon completion.

E. Provide all required inspections and obtain approvals, secure any required certificates of inspection, report forms and approvals, and maintain a copy for submission as part of the operating and maintenance manual.

3.2 TESTING

A. Provide testing of installed work in accordance with the requirements outlined in the Division I specifications

B. The mechanical contractor shall take responsibility for testing, adjustment and demonstration proper operation of all mechanical systems within the scope of this project.

C. Contractor shall notify the construction manager minimum 48 hours in advance of any testing or adjustment procedures of any installed systems or subsystems, to provide the opportunity for those procedures to be witnessed. The construction manager may, at their discretion, require test or adjustment be repeated in the presence if that opportunity is not afforded them.

D. All equipment and components are to be visually checked, tested and verified for proper finished installation, connections and functions, with all adjustments having been made to optimize performance.

E. The contractor is to provide certified factory trained technicians for start-up and testing of new equipment where called for in the individual specification sections for such equipment. Start of investing by local sales representative not be accepted as startup by a factory trained technician. Provide written startup procedures in advance to the construction manager for review before scheduling such factory technician startup

procedures.

F. Do not insulate, cover, or otherwise conceal any equipment, components or materials to be tested or adjusted.

G. The contractor is responsible for providing all test equipment, tools, gauges, meters and personnel as may be necessary to perform tests, demonstrate integrity of the completed installation, to the approval of the Construction Manager and Authority having jurisdiction.

H. Submit all start-up, tests and adjustment procedure results, reports, completed forms to the Construction Manager for review and acceptance promptly upon their completion.

I. Provide all required start-ups, tests, adjustments and obtain approvals, secure any required certificates of completion, report forms and approvals, and maintain a copy of all completed forms and reports for inclusion in the operating and maintenance manual.

3.3 DEMONSTRATION

A. Provide demonstration and training of the installed systems and subsystems in accordance with requirements outlined in the Division I specifications.

B. The mechanical contractor is responsible for demonstrating to the construction manager that all of the HVAC systems are complete and operating properly.

C. Submit to the construction manager a proposed schedule for demonstration and training of systems, including demonstration and training documents and forms, no later than 15 business days prior to substantial completion or approval.

D. Demonstration and training shall only commence after the mechanical contractor has performed all inspections, start-ups and operational tests, complete with successful results, reports and completed startup forms.

E. Provide on-site in-service training for all systems and subsystems, including presentation of related operations and maintenance manuals, systems manuals and related training guides. A minimum of 32 hours of such training shall be provided.

F. Refer to the demonstration and training requirements specific to individual equipment and systems outlined in the specification sections or such equipment and systems.

G. Include instruction on regular maintenance and inspection procedures that are required to be followed by the owner.

H. Document completed demonstration and training on forms which shall include dates,

names of participants, signed by all.

3.4 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.5 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.6 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least [five] <Insert number> pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least [four] <Insert number> pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least [four] <Insert number> pipe fittings, including tee in main.

3.7 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch] [2-inch] <Insert dimension> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches] <Insert dimension> above finished floor level.
3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.8 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.9 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.10 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.11 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending a minimum of 2 inches into fluid one-third of pipe diameter or to center of pipe, and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.

R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

3.12 DEVICE CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.13 DEVICE ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.14 SLEEVE INSTALLATION

A. Sleeves and Sleeve Seals:
   1. Perform the following tests and inspections:
      a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
      b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
   2. Prepare test and inspection reports.

B. Escutcheons:
   1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.15 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above and below Grade:
      a. Sleeves with waterstops.
         1) Select sleeve size to allow for [1-inch] <Insert dimension> annular clear space between piping and sleeve for installing sleeve-seal system.
   2. Concrete Slabs-on-Grade:
      a. Sleeves with waterstops.
         1) Select sleeve size to allow for [1-inch] <Insert dimension> annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs above Grade:
      a. Sleeves with waterstops, or stack-sleeve fittings.
   4. Interior Walls and Partitions:
      a. Sleeves without waterstops.

END OF SECTION 230500

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packless expansion joints.
2. Alignment guides and anchors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 PACKLESS EXPANSION JOINTS

A. Metal, Compensator Packless Expansion Joints: MCEJ-01.

1. Source Limitations: Obtain metal compensator packless expansion joints from single manufacturer.
2. Minimum Pressure Rating: 150 psig unless otherwise indicated.
3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.
    a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
    b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
6. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.
    a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
    b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged, Welded.

B. Metal-Bellows Packless Expansion Joints:

1. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
2. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
5. Configuration: Single joint unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
    a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint, or threaded.
    b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
    c. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.

d. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged or Welded.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Source Limitations: Obtain alignment guides from single manufacturer.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated carbon steel.
   c. Washer and Nut: Zinc-coated carbon steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A307, [zinc-coated carbon] [stainless] steel with continuous thread on stud, unless otherwise indicated.
   c. Washer and Nut: Zinc-coated carbon steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

A. Provide in hydronic piping systems in locations, sizes and quantities recommended by the manufacturer.

B. Install expansion joints of sizes matching sizes of piping in which they are installed.

C. Provide in locations of hydronic systems

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows packless expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints according to FSA-PSJ-703.

3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.4 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves
2. Sealing.
3. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

2.2 SLEEVES WITH WATERSTOP

A. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

2.3 STACK-SLEEVE FITTINGS

A. Description: Manufactured, Dura-coated or Duco-coated, galvanized, cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.4 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psig.
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
3. Pressure Plates: Carbon steel or Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating, of length required to secure pressure plates to sealing elements.

2.5 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 7 specification sections for Penetration Firestopping.

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.3 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 7 specification sections for Sheet Metal Flashing and Trim
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Division 7 specification sections for Penetration Firestopping.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.6 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:
    a. Sleeves with waterstops.
        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
2. Concrete Slabs-on-Grade:
    a. Sleeves with waterstops.
        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs above Grade:

a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

END OF SECTION 230517

SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers, bimetallic actuated.
2. Thermometers, filled system.
3. Thermometers, liquid in glass.
4. Duct-thermometer mounting brackets.
5. Thermowells.
6. Pressure gauges, dial type.
7. Gauge attachments.
8. Test plugs.
9. Test-plug kits.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Include performance information, control diagrams.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of gauge or meter.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 THERMOMETERS, BIMETALLIC ACTUATED

A. Manufacturers: Subject to compliance with requirements provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ashcroft Inc
2. Marsh Bellofram
3. Palmer Wahl Instrumentation Group

4. Trerice, H. O. Co
5. WATTS; A Watts Water Technologies Company
6. Weiss Instruments, Inc

B. Source Limitations: Provide bimetallic-actuated, lead-free thermometers from a single manufacturer.

C. Standard: ASME B40.200.

D. Case: Liquid-filled, sealed type(s); stainless steel with 3-inch nominal diameter.

E. Dial: Nonreflective aluminum with permanent scale markings in deg F and deg C.

F. Connector Type(s): Union joint, adjustable angle, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: acrylic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of span.

2.2 THERMOMETERS, FILLED SYSTEM

A. Thermometers, Filled System - Direct Mounted, Metal Case, Vapor Actuated:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ashcroft Inc
   b. Marsh Bellofram
   c. Palmer Wahl Instrumentation Group
   d. Trerice, H. O. Co
   e. WATTS; A Watts Water Technologies Company
   f. Weiss Instruments, Inc
2. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
3. Standard: ASME B40.200.
4. Case: Sealed type, cast aluminum 4-1/2-inch nominal diameter.
5. Element: Bourdon tube.

6. Movement: Mechanical dampening type, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in deg F and deg C.
8. Pointer: Dark-colored metal.
9. Window: safety glass or acrylic plastic.
10. Ring: Stainless steel
11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device, ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
12. Thermal System: Liquid-filled, mercury-free bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
13. Accuracy: Plus or minus 1 percent of span.

2.3 THERMOMETERS, LIQUID IN GLASS

A. Thermometers, Liquid in Glass - Metal Case, Compact Style:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Ashcroft Inc
    b. Marsh Bellofram
    c. Palmer Wahl Instrumentation Group
    d. Trerice, H. O. Co
    e. WATTS; A Watts Water Technologies Company
    f. Weiss Instruments, Inc
2. Source Limitations: Provide liquid-in-glass, metal-case, compact-style thermometers by single manufacturer.
3. Standard: ASME B40.200.
4. Case: Cast aluminum 6-inch nominal size.
5. Case Form: Back angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue or red organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F and deg C.
8. Window: acrylic
9. Stem: Aluminum or brass and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
10. Connector: 3/4 inch, with ASME B1.1 or ASME B1.20.1 screw threads, to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum

of 1.5 percent of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: Copper.
4. Material for Use with Steel Piping: Type 304 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, with ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.6 PRESSURE GAUGES, DIAL TYPE

A. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following available manufacturers offering products that may be incorporated into the Work:
    a. Ashcroft Inc
    b. Marsh Bellofram
    c. Palmer Wahl Instrumentation Group
    d. Trerice, H. O. Co
    e. WATTS; A Watts Water Technologies Company
    f. Weiss Instruments, Inc
2. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: Liquid-filled, Sealed, cast aluminum or drawn steel 4-1/2-inch nominal diameter.

5. Pressure-Element Assembly: Bourdon tube.
6. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in psi and kPa.
9. Pointer: Dark-colored metal.
10. Window: acrylic
11. Ring: Stainless steel.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

2.7 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS ¼ ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless steel pipe with NPS 1/4 pipe threads.

C. Valves: Brass or stainless steel needle, with NPS 1/4 ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

A. Source Limitations: Provide test plugs from single manufacturer.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber.

2.9 TEST-PLUG KITS

A. Source Limitations: Provide test-plug kits from single manufacturer.

B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range is to be at least 25 to 125 deg F (and

deg C).

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F (and deg C).

E. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range is to be at least 0 to 100 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid, one-third of pipe diameter or to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.

R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

U. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

V. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Inlet and outlet of each hydronic coil in air-handling units.
4. Outside-, return-, supply-, and mixed-air ducts.

W. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water connection.
3. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at to be provided at inlet and outlet of each hydronic, and as shown on the plans.

B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and as shown on plans.

C. Thermometers at outside-, return-, supply-, and mixed-air ducts, and as shown on plans.

D. Thermometer stems are to be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping:

1. 0 to plus 100 deg F and deg C.

B. Scale Range for Heating, Hot-Water Piping:

1. 20 to 240 deg F, and deg C.

C. Scale Range for Air Ducts:

1. 0 to 100 deg F, and deg C.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges at discharge of each pressure-reducing valve.

B. Pressure gauges at inlet and outlet of each chiller, chilled-water and condenser-water connection.

C. Pressure gauges at suction and discharge of each pump

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping:

1. 0 to 100 psi and in kPa.

B. Scale Range for Heating, Hot-Water Piping:

1. 0 to 100 psi (and in kPa).

END OF SECTION 230519

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Stainless steel ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

B. Manufacturers: Subject to compliance with requirements, provide products by one of

the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A.Y. McDonald Mfg. Co
2. American Valve, Inc
3. Apollo Valves
4. Hammond Valve
5. Jenkins Valves; a Crane Co. brand
6. Jomar Valve
7. Milwaukee Valve Company
8. Stockham; a Crane Co. brand
9. Viega LLC
10. WATTS; A Watts Water Technologies Company

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections.
8. ASME B31.1 for power piping valves.
9. ASME B31.9 for building services piping valves.

B. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Hand Lever: For quarter-turn valves smaller than NPS 4.

F. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material, and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 STAINLESS STEEL BALL VALVES

A. Bronze Ball Valves, Solid stainless steel ball and trim, Two Piece with Full Port, Threaded or Flanged Ends:

1. Standard: MSS SP-110.
2. CWP Rating: 200 psig.
3. Body Design: Split body.
4. Body Material: Cast bronze.
5. Ends: Threaded or flanged.
6. Seats: PTFE.
7. Stem: Type 316 stainless steel.
8. Ball: Type 316 stainless steel.
9. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, provide the same types of valves with higher SWP classes or CWP ratings.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller: bronze ball valves, two piece, with stainless steel ball and trim, full port, and threaded or solder joint ends.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller: bronze ball valves, two piece, with stainless steel ball and trim, full port, and threaded or solder joint ends.

END OF SECTION 230523.12

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron, single-flange (lug-type) butterfly valves.
2. Iron, flangeless (wafer-type) butterfly valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: ABS, Buna-N, or nitrile butadiene rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

B. Manufacturers: Subject to compliance with requirements, products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Apollo Valves;
2. DeZURIK
3. Hammond Valve
4. Jenkins Valves; a Crane Co. brand
5. Jomar Valve
6. Kennedy Valve Company; a division of McWane, Inc.
7. Milwaukee Valve Company
8. Mueller Steam Specialty; A Watts Water Technologies Company
9. NIBCO INC.
10. Stockham; a Crane Co. brand
11. Viega LLC
12. WATTS; A Watts Water Technologies Company
13. Zurn Industries, LLC

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Hand Lever: For valves NPS 6 and smaller.

F. Valves in Insulated Piping: Provide with 2-inch extended neck stems.

2.3 IRON, SINGLE-FLANGE (LUG-TYPE) BUTTERFLY VALVES

A. Iron, Single-Flange (Lug-Type) Butterfly Valves with Stainless Steel Disc:

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 150 psig.

3. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM or NBR, as medium dictates.
6. Stem: One- or two-piece stainless steel.
7. Disc: Stainless steel.

2.4 IRON, FLANGELESS (WAFER-TYPE) BUTTERFLY VALVES

A. Iron, Flangeless (Wafer-Type) Butterfly Valves with Stainless Steel Disc:

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 150 psig.
3. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM or NBR, as medium dictates.
6. Stem: One- or two-piece stainless steel.
7. Disc: Stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. If leakage cannot be repaired, replace valve.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Larger:

1. Iron, lug type Butterfly Valves, Ductile-iron, stainless steel disc, 150 CWP, and EPDM or NBR seat as recommended by manufacturer for medium served.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Larger:

1. Iron, lug type Butterfly Valves, Ductile-iron, stainless steel disc, 150 CWP, and EPDM or NBR seat as recommended by the manufacturer for the medium served.

END OF SECTION 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze swing check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. NBR: Nitrile butadiene rubber (also known as "Buna-N").

D. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, press connections, and weld ends.
3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work:

1. Apollo Valves;
2. Crane Fluid Systems; Crane Co]
3. Jenkins Valves; a Crane Co. brand
4. Jomar Valve
5. Milwaukee Valve Company
6. NIBCO INC
7. Stockham; a Crane Co. brand
8. Victaulic Company

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges for metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B31.1 for power piping valves.
8. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE SWING CHECK VALVES

1. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that

there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

I. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends, except where solder-joint option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.

END OF SECTION 230523.14

SECTION 230523.15 - GATE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze gate valves.
2. Iron gate valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Non-rising stem.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels, stems, or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Valve, Inc
2. Apollo Valves
3. Crane Fluid Systems; Crane Co
4. Jenkins Valves; a Crane Co. brand
5. Milwaukee Valve Company
6. Powell Valves
7. Stockham; a Crane Co. brand
8. WATTS; A Watts Water Technologies Company

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B16.34 for flanged, threaded, and welding ends.
8. ASME B31.1 for power piping valves.
9. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. RS Valves in Insulated Piping: With 2-inch stem extensions.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.4 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, Class 125:

1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves so that stems are horizontal or slope upward from centerline of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

I. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Gate valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends, except where solder-joint or press valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze valves, Class 125 with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS or OS&Y, Class 125.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze valves, Class 125 with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS or OS&Y, Class 125

END OF SECTION 230523.15

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment stands.
7. Equipment supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Environmental Product Declaration: For each product.
5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
6. Third-Party Certifications: For each product.
7. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.

4. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 specification sections for Quality Requirements, to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. Manufacturer of hangers and supports:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following that may be incorporated into the Work include, but are not limited to, the following:
2. Anvil International/Smith-Cooper International; Tailwind Capital, LLC
3. CADDY; brand of nVent Electrical plc

4. Carpenter & Paterson, Inc
5. Empire Industries, Inc.
6. MIRO Industries
7. PHD Manufacturing, Inc
8. RectorSeal HVAC

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Adjustable band type hangers, type 10, MSS-SP-69.
3. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel or stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.

4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel or stainless steel.
7. Metallic Coating, Hot-dip galvanized.
8. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi, ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi, minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Reversible beam clamps of malleable iron with electro-galvanized finish, locking nut and retaining strap for retrofit application, MSS-Sp-69, UL listed.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Provide adjustable band hangers for piping exposed to public view, nut and threaded rod on top, paint ready finish.

C. Provide padded clevis type hangers for insulated piping where exposed to public view, nut and threaded rod on top, paint ready finish.

D. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe

size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

E. Install hangers and attachments as required to properly support piping from building structure.

F. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

G. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

H. Fastener System Installation:

1. Powder-actuated fasteners will not be acceptable for this project
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

I. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

Q. Insulated Piping:

1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers,and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
2. Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems, and attachments for general service applications.

F. Use stainless steel pipe hangers and stainless steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 2.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 2.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.

11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
4. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
5. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Post-installed concrete anchors.
4. Concrete inserts.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. OMC 2017: Ohio Mechanical Code 2017.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and wind-force-restraint component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators, wind-load restraints, and vibration isolation bases complying with

performance requirements, design criteria, and analysis data.

b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.

d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Wind-Restraint Detail Drawing:

a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

4. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, UL, FM Approvals showing maximum ratings of restraint items and basis for approval (tests or calculations).

5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.

6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints. Refer to section 230500.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data.

E. Field quality-control reports.

F. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, UL product listing, FM Approvals, an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 specification section for Quality Requirements, to design system.

1. Wind-Load Performance: Equipment shall withstand the effects of high wind events determined in accordance with ASCE/SEI 7-05.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ace Mountings Co., Inc
2. CADDY; brand of nVent Electrical plc
3. Isolation Technology, Inc
4. Kinetics Noise Control, Inc
5. Mason Industries, Inc
6. Vibration Management Corp
7. VMC GROUP
8. CurbTech

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05, ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate design wind-load calculations with vibration isolation requirements. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" less than 60 feet.

d. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
4. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" greater than 60 feet.
   d. PART 4: Buildings with "h" less than 160 feet.
   e. PART 5: Open Buildings.
5. Design wind pressure "p" for rooftop equipment is to be calculated by manufacturer's design contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
6. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

D. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of roof-mounted HVAC components as indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

E. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Minimum deflection as indicated on Drawings.
4. Pad Material: Oil- and water-resistant rubber.

5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
    a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts:

1. Mounting Plates:
    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Minimum deflection as indicated on Drawings.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
3. Powder actuated anchors will not be acceptable.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.5 CONCRETE INSERTS

A. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

B. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION AND WIND-LOAD CONTROL DEVICES

A. Provide vibration and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3 specification sections for Cast-in-Place Concrete.

C. Installation of vibration isolators[and wind-load restraints] must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Comply with requirements in Division 7 specification sections for Roof Accessories for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate

snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install wind-load-restraint devices using methods approved by [an evaluation service member of ICC-ES, an agency acceptable to authorities having jurisdiction, that provides required submittals for component.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the

bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

9. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless steel rivets or self-taping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Material: Vinyl.

B. Minimum Thickness: 0.005 inch.

C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

E. Maximum Temperature: 160 deg F.

F. Minimum Width: 2 inches.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or fully cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping, at least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.
3. Lettering Size: size letters in accordance with ASME A13.1 for piping, at least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.024-inch or aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire, link chain, beaded chain, or S-hook.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Where identification is to be provided for piping, ducts or other system components visible to the occupants in finished spaces, position labels, tags, signage, tapes, near top side to make them less noticeable to occupants.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

E. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-blue background.

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes color, marking pattern, text.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Division 9

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes

where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Natural Gas: Black letters on an ANSI Z535.1 safety-yellow background.
4. Potable and Other Water: White letters on an ANSI Z535.1 safety-green background.

3.6 INSTALLATION OF DUCT LABELS

A. Install plastic-laminated duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For air supply ducts: White letters on blue background.
b. For air return ducts: White letters on blue background.
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.

B. Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

1. For all air ducts: Black letters on white background

C. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

3.7 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Chilled Water: 1-1/2 inches, round or square.
b. Hot Water: 1-1/2 inches, round or square.
c. Gas: 1-1/2 inches, round or square

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring

system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:
    a. Constant-volume air systems.
    b. Variable-air-volume systems.
2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
    a. Constant-flow hydronic systems.
    b. Variable-flow hydronic systems.
    c. Primary-secondary hydronic systems.
3. Testing, adjusting, and balancing of equipment.
4. Testing, adjusting, and balancing of existing HVAC systems and equipment.
5. Procedures for exhaust hoods.
6. Sound tests.
7. Duct leakage tests verification.
8. Pipe leakage tests verification.
9. HVAC-control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. AHJ: Authority Having Jurisdiction

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.3 TAB SPECIALISTS

A. Subject to compliance with these requirements, and owner approval, engage a TAB firm specializing in the work of this section; and that is a firm independent of the installing contractor.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at the site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

A. Submit for review and approval proposed independent TAB firm, and assigned team members. Prepare and submit within 1 week from notice to proceed.

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

D. Strategies and Procedures Plan: Within 45 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

E. System Readiness Checklists: Within 45 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Certified TAB reports.

H. Sample report forms.

I. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. Provide the services of an independent TAB firm to perform Testing, Adjusting and Balancing for the project.

B. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

C. TAB Specialists Qualifications, Certified by NEBB or TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

F. Code and AHJ Compliance: TAB is required to comply with Ohio Building Code 2017, and governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations. Refer to the phasing plans in the project drawings.

B. Partial Owner Occupancy: Owner will occupy temporarily, pre-identified portions of the building, and will move into and occupy other completed areas of building before Substantial Completion of the entire project. Plan work accordingly and cooperate closely with the project manager and Owner during TAB operations to minimize conflicts with Owner's operations. Refer to the phasing plans in the project drawings.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, and owner approval, engage the TAB firm for planning and pre-installation meeting before beginning any installation of new

systems.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer

baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report, to the construction manager, in writing, deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:
    a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    b. Duct systems are complete with terminals installed.
    c. Volume, smoke, and fire dampers are open and functional.
    d. Clean filters are installed.
    e. Fans are operating, free of vibration, and rotating in correct direction.
    f. Variable-frequency controllers' startup is complete and safeties are verified.
    g. Automatic temperature-control systems are operational.
    h. Ceilings are installed.
    i. Windows and doors are installed.
    j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
    a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.

b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning in accordance with the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Pumps.

3. Fans and ventilators.
4. Terminal units.
5. Boilers.
6. Unit heaters.
7. Water chillers.
8. Air-handling units.
9. Rooftop air-conditioning units.
10. Coils.
11. Fan coil units.
12. Unit ventilators.
13. Ductless heat pump.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.

3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer. Series fan powered terminals will include ECM fan motors and factory adjustment knob on unit housing for speed setting.
    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-

handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return, exhaust/relief and outside airflows to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
10. Repeat the process for testing, adjusting and balancing the system in the economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data. Verify tracking between supply and return fans.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   5. Verify that motor controllers are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

1. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:

1. Adjust pumps to deliver total design flow.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
    b. Measure pump TDH as follows:
        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
    c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
    a. Measure differential pressure and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
    a. Re-measure and confirm that total flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

D. For systems with flow diversity:
1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were

just opened.

9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first, assure final flow rate meets boiler manufacturer’s recommendations.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design flow.

1. Measure total water flow.
    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
    d. Establish pump manufacturer minimum flow in heating hot water secondary loop system for each/both heating hot water system pumps.
2. Measure pump TDH as follows:
    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
3. Monitor motor performance during procedures, and do not operate motor in an

overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position three-way control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.11 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.

5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.12 PROCEDURES FOR WATER CHILLERS

A. Air-Cooled Chillers: Balance water flow through each evaporator to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
7. Verify condenser-fan rotation and record fan and motor data, including number of fans and entering- and leaving-air temperatures.
8. Establish chiller manufacturer minimum flow in chilled water system and through chiller.

3.13 PROCEDURES FOR AIR-COOLED CONDENSING UNITS AND HEAT PUMPS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.14 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.

3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Fuel Consumption: If boiler fuel supply is equipped with flow meter, measure and record consumption.
7. Establish boiler manufacturer minimum flow in primary loop and through each/both boilers.
8. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
9. Fan, motor, and motor controller operating data.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.16 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.17 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.18 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.19 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus 10 percent or minus 10 percent, If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: Plus or minus 5 percent.
4. Chilled-Water Flow Rate: Plus or minus 5 percent

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.20 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for

each system and each building floor for systems serving multiple floors.

3.21 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.

c. Cooling coil, wet- and dry-bulb conditions.
d. Heating coil, dry-bulb conditions.
e. Face and bypass damper settings at coils.
f. Fan drive settings, including settings and percentage of maximum pitch diameter.
g. Variable-frequency controller settings for variable-air-volume systems.
h. Settings for pressure controller(s).
i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:

a. Variable-frequency controller settings for variable-flow hydronic systems.
b. Settings for pressure controller(s).
c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram produced with electronic drafting software (AutoDesk) and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Inlet and discharge static pressure in inches wg.
e. For each filter bank, filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.

l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and speed.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

3. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.

d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.

h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump

curves, and include the following:

1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and size.
    e. Model number and serial number.
    f. Water flow rate in gpm.
    g. Water pressure differential in feet of head or psig.
    h. Required net positive suction head in feet of head or psig.
    i. Pump speed.
    j. Impeller diameter in inches.
    k. Motor make and frame size.
    l. Motor horsepower and rpm.
    m. Voltage at each connection.
    n. Amperage for each phase.
    o. Full-load amperage and service factor.
    p. Seal type.
2. Test Data (Indicated and Actual Values):
    a. Static head in feet of head or psig.
    b. Pump shutoff pressure in feet of head or psig.
    c. Actual impeller size in inches.
    d. Full-open flow rate in gpm.
    e. Full-open pressure in feet of head or psig.
    f. Final discharge pressure in feet of head or psig.
    g. Final suction pressure in feet of head or psig.
    h. Final total pressure in feet of head or psig.
    i. Final water flow rate in gpm.
    j. Voltage at each connection.
    k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:
    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

3.22 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 20 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.23 ADDITIONAL TESTS

A. After 120 days from date of accepted completion of TAB, perform additional TAB, repeating the field procedures for the completed and installed systems from the initial field procedures to verify that balanced conditions are being maintained throughout, and to provide correction of unusual or dis-satisfactory conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For coatings, indicating VOC content.
4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.
6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.

3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and leak testing of ductwork. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed on the project; Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. CertainTeed; SAINT-GOBAIN
    b. Johns Manville; a Berkshire Hathaway company
    c. Knauf Insulation
    d. Manson Insulation Inc.
    e. Owens Corning

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thermal performance minimum k-value of .24 (btu-in/hr-sf) at 75F differential.

G. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and

between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thermal performance minimum k value of .24 (btu-in/hr-sf) at 75F.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. VOC Content: 300 g/L or less.

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

A. Lagging Adhesives: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.

1. Adhesives shall have a VOC content of 50 g/L or less.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials are compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. Sealant shall have a VOC content of 420 g/L or less.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 FIELD APPLIED JACKETS

A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled, roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

B. Aluminum, Corrugated or stucco embossed, 0.024 inch thick.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness:6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel in accordance with ASTM A240/A240M, Type 304.

2.11 FIELD APPLIED REMOVEABLE JACKETS

A. Custom ordered and fabricated by manufacturer specializing in fabrication of custom removeable insulating blankets, minimum 1” mechanically bonded fiberglass insulation of minimum 10 pcf density, sound barrier acoustic insulation with noise reduction at 1” equivalent to NRC .75, silicone impregnated outer cover finish of white color, UL listed. Jacket of sewn construction with ribbon trim fit tight to required openings for air intake

filter, coil piping connections, controls panel access, inlet and outlet ductwork, straps to secure tight to unit, held with Velcro, buttons or snaps.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents[, unless otherwise approved by the engineer-of-record].

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inche o.c.
    a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof

surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and

transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
    1. Apply adhesives according to manufacturer's recommended coverage rates per

unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over-compress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.
9. Outdoor air intake plenum.

B. Items Not Insulated:

1. Double wall ducts with interstitial insulation
2. Insulated flexible duct
3. Factory-insulated cabinets, access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct insulation:

1. Glass-Fiber Blanket: 1-1/2 inches thick and 3 lb/cu. ft. nominal density.
2. Round, flat-oval, rectangular, up to 30” wide duct
3. Duct with dimension over 30”; Glass-Fiber Board: 1-1/2 inches and 3 lb/cu. ft. nominal density

B. Concealed, return-air duct insulation:

1. Glass-Fiber Blanket: 1-1/2 inches thick and 1.5 lb/cu. ft. nominal density.
2. Round, flat oval, rectangular, up to 30” wide duct
3. Duct with dimension over 30”; Glass-Fiber Board: 1-1/2 inches and 3 lb/cu. ft. nominal density

C. Concealed, exhaust-air duct insulation:

1. Glass-Fiber Blanket: 1-1/2 inches thick and 1.5 lb/cu. ft. nominal density.
2. Round, flat oval, rectangular
3. Sections within 15 ft run of exterior of building

D. Concealed, high velocity exhaust-air duct insulation (laser exhaust):

1. Glass-Fiber Blanket: 1-1/2 inches thick and 1.5 lb/cu. ft. nominal density.
2. Entire length except where exposed to view indoors..

E. Exposed, supply-air duct insulation:

1. Glass-Fiber Board: 1-1/2 inches thick and 3 lb/cu. ft. nominal density; for rectangular and flat-oval.
2. Glass-Fiber Pipe and Tank: 1-1/2 inches thick, 3 lb/cuft nominal density; for round ducts.

F. Exposed, return-air duct insulation:

1. Glass-Fiber Board: 1-1/2 inches thick and 2 lb/cu. ft. nominal density; rectangular and flat-oval.
2. Round, flat-oval, rectangular, up to 30” wide duct
3. Glass-Fiber Pipe and Tank: 1-1/2 inches thick, 2 lb/cuft nominal density; round ducts..

G. Exposed, outdoor-air duct insulation:

1. Glass-Fiber Board: 1-1/2 inches thick and 3 lb/cu. ft. nominal density; for rectangular and flat-oval.
2. Glass-Fiber Pipe and Tank: 1-1/2 inches thick, 3 lb/cuft nominal density; for round ducts.
3. Plenum behind louver: Glass-Fiber Board: 2 inches thick and 3 lb/cu. ft. nominal density.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exposed insulated ducts in view:

1. PVC, 30 mils thick.

D. Exposed insulated ducts and plenums in mechanical rooms

1. Aluminum, 0.024 inch thick.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For sealants, indicating VOC content.
3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program[, certified by the Department of Labor, Bureau of Apprenticeship and Training].

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size[, as well as ASTM standard designation, and maximum use temperature].

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed; SAINT-GOBAIN

2. Johns Manville; a Berkshire Hathaway company
3. Knauf Insulation
4. Manson Insulation Inc
5. Owens Corning

2.2 INSULATION MATERIALS

A. Comply with requirements in "Indoor Equipment Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type II, with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

F. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. Semirigid board material with factory-applied ASJ jacket.
2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.

2.4 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor and outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: [0 to plus 180 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

A. Lagging Adhesives: Adhesives comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.

1. Adhesive shall be as recommended by insulation manufacturer and shall have a VOC content of 50 g/L or less.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
3. Service Temperature Range: 20 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
2. Service Temperature Range: Minus 58 to plus 176 deg F.
3. Color: White or gray.
4. Sealant shall have a VOC content of 420 g/L or less.

2.7 FACTORY-APPLIED JACKETS

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing;

complying with ASTM C1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White or color as selected by Architect.
3. Factory-fabricated tank heads and tank side panels.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30-mils- thick, minimum 1- by 1-inch PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch thick, minimum 1- by 1-inch aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles:[0.024-inch thick, minimum 1- by 1-inch stainless steel in accordance with ASTM A240/A240M, Type 304.

2.10 REMOVABLE INSULATION UNITS

A. Factory custom fabricated, sewn construction, built to order; field measured for specific application and items to be insulated. Three layer insulating cover, pliable and easily removable and easily replaceable without degradation to the cover or its fasteners. ISO 9001 2015 certified, rated to 500F.

1. Silicone impregnated, Teflon reinforced fiberglass outer layer protective cover with smooth finish, in grey or other manufacturer standard color, with teflon-coated fiberglass adhered to the interior side of the cover.
2. Silicone impregnated fiberglass interior layer to fit tight to surfaces and contours of equipment to be insulated; with teflon-coated fiberglass adhered to the interior side of the cover.

3. Fiberglass fill between layers, 1 inch thickness minimum to provide minimum R-value of 6. Cutouts, flaps and closures to fully enclose equipment and maximize thermal coverage, held in position with fasteners which include buckles, draw cords, lacing wires.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of

thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents[, unless otherwise approved by the engineer-of-record].

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at

2 inches o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Glass-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints and 16 inches o.c. in both directions.
    d. Do not compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins, and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.6 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.7 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections: Inspect field-insulated equipment, randomly selected by

Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule" and "Outdoor, Aboveground Equipment Insulation Schedule" articles. For large equipment, remove only a portion adequate to determine compliance.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.

3.9 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment that is not factory insulated.

B. Heating-hot-water pumps insulation:

1. Custom fabricated removable jacket unit, fiberglass.

C. Heating-hot-water expansion/compression tank insulation is one of the following:

1. Glass-Fiber Board: 2 inches thick and 2 lb/cu. Ft nominal density.
2. Glass-Fiber Pipe and Tank: 2 inches thick.
3. Mineral Wool Pipe and Tank: 2 inches thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Tanks and vessels:

1. PVC: 30 mils thick.
2. Aluminum, Corrugated or Stucco Embossed 0.020 inch thick.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 230716 "HVAC Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program[, certified by the Department of Labor, Bureau of Apprenticeship and Training].

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size[, as well as ASTM standard designation, and maximum use temperature].

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Johns Manville; a Berkshire Hathaway company
2. Knauf Insulation
3. Manson Insulation Inc
4. Owens Corning

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.

1. Minimum k-factor of .23 btu-in/hr-sf at 75 degree F differential thermal performance.
2. Preformed Pipe Insulation: Type I, Grade A with factory-applied with factory-applied ASJ+ jacket.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. Semirigid board material with factory-applied ASJ+ jacket.
2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Minimum k-factor of .23 btu-in/hr-sf at 75 degree F differential thermal performance.

2.3 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.

B. Glass-Fiber and Mineral Wool Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 LAGGING ADHESIVES

A. Lagging Adhesives: Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.

1. Adhesive shall be as recommended by insulation manufacturer and shall have a VOC content of 50 g/L or less.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 20 to plus 180 deg F.

4. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
   a. Service Temperature Range: Minus 150 to plus 250 deg F.
   b. Color: White or gray.
2. Sealant shall have a VOC content of 420 g/L or less.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White or color as selected by Architect].
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical

joints, and P-trap and supply covers for lavatories.

D. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

2.10 TAPES

A. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches
2. Film Thickness: 2 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 120 percent.
5. Tensile Strength: 20 psi in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Examine conditions of existing insulation, confirm satisfactory conditions for locations where new insulation and field applied jackets must meet and join existing; report deficiencies, in writing, to the construction manager.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Provide extension of new insulation and jackets up to 4 additional feet beyond connection point where new insulation must join existing insulation, to replace damaged or non-satisfactory conditions of existing.

E. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

F. Where insulated piping will be visible in occupied finished spaces, position longitudinal seams near top such that they are less noticeable to occupants.

G. Install multiple layers of insulation with longitudinal and end seams staggered.

H. Do not weld brackets, clips, or other attachment devices to piping, fittings, and

specialties.

I. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

J. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

K. Install insulation with least number of joints practical.

L. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

N. Provide sealants, mastics, adhesives, cements specifically selected to join new and existing insulation and jacket products, assuring proper thermal and vapor seal for entire system.

O. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

S. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation

continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 7 specification sections for Penetration Firestopping for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 specification sections for Penetration Firestopping.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using prefabricated fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with prefabricated fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using prefabricated fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using prefabricated fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than

2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and

protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 specification sections for Exterior Painting and Interior Painting.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.9 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

E. All insulation applications will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Chilled Water, 50 Deg F and below:
   1. NPS 4 pipe size and Smaller: Insulation:
      a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

C. Heating-Hot-Water Supply and Return, 150 Deg F and Below:
   1. NPS 4 and Smaller: Insulation:
      a. Glass-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. PVC, white or Color-select by Architect: 20 mils thick.

END OF SECTION 230719

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct digital control (DDC) system equipment and components for updating the existing system for the purpose of monitoring and controlling of new and existing HVAC, exclusive of instrumentation and control devices.

B. Related Requirements:

1. Section 230923.11 "Control Valves”.
2. Section 230923.12 "Control Dampers”.
3. Section 230923.14 "Flow Instruments”
4. Section 230923.19 "Moisture Instruments”
5. Section 230923.23 “Pressure Instruments”
6. Section 230923.27 “Temperature Instruments”
7. Section 230993.11 "Sequence of Operations for HVAC DDC"

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BAS: Building Automation System, a software-based system for monitoring and controlling building application such as heating, ventilation and air-conditioning control, energy management, lighting control.

D. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135-2020. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing

products for compliance with ASHRAE Standard 135-2020, operated under direction of BACnet International.1

E. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

F. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

G. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

H. COV: Changes of value.

I. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

J. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

K. E/P: Voltage to pneumatic.

L. Front-end (or “Head-end”) is the BAS software resident in the OWS which manages, controls, commands and monitors all BAS system functions and interfaces, including interfaces to the internet, and is also responsible for generating the graphical user interface whereby Owners monitor, input, and operate the systems served by the BAS.

M. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

N. HLC: Heavy load conditions.

O. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

P. LAN: Local area network.

Q. LNS: LonWorks Network Services.

R. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

S. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

T. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

U. Modbus TCP/IP: An open protocol for exchange of process data.

V. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

W. MTBF: Mean time between failures.

X. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

Y. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

Z. OWS: Operator Work Station, serving as the central data and command terminal for the BAS, a high level-processing desktop personal computer which acts as the main point of user interface.

AA. Peer to Peer: Networking architecture that treats all network stations as equal partners.

BB. POT: Portable operator's terminal.

CC. RAM: Random access memory.

DD. RF: Radio frequency.

EE. Router: Device connecting two or more networks at network layer.

FF. Server: Computer used to maintain system configuration, historical and programming database.

GG. TCP/IP: Transport control protocol/Internet protocol.

HH. Thick client: BAS system operator interface device with front-end software installed on the client device.

II. Thin client: BAS system operator interface device where communication with the front-end software is through the internet or other network.

JJ. USB: Universal Serial Bus.

KK. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

LL. VAV: Variable air volume.

MM. WLED: White light emitting diode.

NN. ASHRAE 13: Titled “Specifying Building Automation Systems”, ASHRAE Guideline 13 – 2015, developed and published by ASHRAE to provide designers of building automation systems with background information, recommendations for good practice, project considerations, and detailed discussion of options with respect to design of a building automation system.

OO. ASHRAE 35: Titled “BACnet – A Data Communication Protocol for Building Automation and Control Networks”, ASHRAE Guideline 135-2020, developed and published by ASHRAE for the purpose of the communication needs of the building automation and controls systems for application such as heating, ventilation and air-conditioning control, energy management, lighting control. The BACnet protocol provides mechanisms by which computerized equipment of arbitrary function may exchange information, regardless of the particular building service it performs; and the protocol may be used by mobile and cloud-hosted devices, head-end computers, general-purpose direct digital controllers, and application-specific and unitary controllers with equal effect.

PP. ASHRAE 36: Titled “High-Performance Sequence of Operations for HVAC Systems”, ASHRAE Guideline 36-2021, including appendix C, developed and published by ASHRAE for the purpose of providing uniform sequences of operation for heating, ventilating, and air conditioning system that are intended to maximize performance and energy efficiency, stability and allow for real-time fault detection and diagnostics. The guideline provides detailed sequences of operation for HVAC, and describes functional tests for confirmation of the proper implementation of sequences of operation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site minimum 2 weeks before scheduled start of any field work.

1.4 ACTION SUBMITTALS

A. Submit following procedures outlined in Division 1. Minimum three complete sets of controls drawings.

1. Displaying control equipment and components for each of the various systems, identifying functions. Include all values, calibration values and setpoints, and set up parameters.. Include the proposed sequence of operation for systems.

2. Include all application software documentation for the actual programs, including job specific flowcharts for the DDC systems.

B. Provide in common software formats, editable and printable (eg AutoCAD, .pdf, .doc, .xls), all text searchable. Submit both the files and printed full sized.

C. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

D. Product Data:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
    a. Workstations.
    b. Gateways.
    c. Routers.
    d. Protocol analyzers.
    e. DDC controllers.
    f. Enclosures.
    g. Electrical power devices.
    h. Accessories.
    i. Instruments.
    j. Control dampers and actuators.
    k. Control valves and actuators.
    l. Application Specific Controllers
    m. Sensors.
6. When manufacturer's product datasheets apply to a product series rather than a

specific product model, clearly indicate and highlight only applicable information.

7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

E. Software Submittal:

1. The new control system shall use the existing headend software on the existing OWS (server) for the building automation system communication
2. The new control system shall fully integrate into the existing systems to completely communicate to existing OWS, web-servers.
3. The system shall provide all communication between DDC panels, controllers, modules, I/O points, schedules, setpoints, alarms and trends as specified in these documents.
4. Cross-referenced listing of existing head-end software loaded on the existing server, software to be loaded to portable operator workstation, and DDC controllers, including any updates or additions to the existing head-end software.
5. Description and technical data of all software, both existing and new to be provided, and cross-referenced to products in which software will be installed.
6. Operating system software, both existing and necessary updates and additions to be provided, detailing operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
7. Include a flow diagram in the form of a complete control system “architecture” and an outline of each subroutine that indicates each program variable name and units of measure.
8. Listing and description of each engineering equation used with reference source.
9. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
10. Description of operator interface to alphanumeric and graphic programming.
11. Description of each network communication protocol.
12. Description of system database, including all data included in database, database capacity, and limitations to expand database.
13. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden, and system throughout.
14. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

F. Shop Drawings:

1. General Requirements:
    a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
    b. Include a drawing index sheet listing each drawing number and title that

matches information in each title block.
c. Drawings Size: 17 by 11, submitted in both electronic format and .pdf format.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Full Plan Drawings indicating the following:
   a. Backgrounds of space, walls, structural grid lines.
   b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
   c. Locations of workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller.
   d. Network communication cable and raceway routing.
6. Schematic drawings for each controlled HVAC system indicating the following:
   a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
   b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
   c. A graphic showing location of control I/O in proper relationship to HVAC system.
   d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
   e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
   f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
   g. Narrative sequence of operation.
   h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
   a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
   b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
8. DDC system network riser diagram indicating the following:
   a. Each device connected to network with unique identification for each.
   b. Interconnection of each different network in DDC system.

c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:
   a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
   c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   d. Power wiring type and size, race type, and size for each.
10. Monitoring and control signal diagrams indicating the following:
   a. Control signal cable and wiring between controllers and I/O.
   b. Point-to-point schematic wiring diagrams for each product.
   c. Control signal tubing to sensors, switches, and transmitters.
   d. Process signal tubing to sensors, switches, and transmitters.
11. Color graphics indicating the following:
   a. Itemized list of color graphic displays to be provided.
   b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
   c. Intended operator access between related hierarchical display screens.

G. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:
   a. Loss of power.
   b. Loss of network communication signal.
   c. Loss of controller signals to inputs and outpoints.
   d. Operator workstation failure.
   e. Server failure.
   f. Gateway failure.
   g. Network failure.
   h. Controller failure.
   i. Instrument failure.

j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

H. Delegated Design Submittals: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.
   a. Flow at Project design and minimum flow conditions.
   b. Face velocity at Project design and minimum airflow conditions.
   c. Pressure drop across damper at Project design and minimum airflow conditions.
   d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
   e. Maximum close-off pressure.
   f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
   g. Torque required at worst case condition for sizing actuator.
   h. Actuator selection indicating torque provided.
   i. Actuator signal to control damper (on, close, or modulate).
   j. Actuator position on loss of power.
   k. Actuator position on loss of control signal.
3. Schedule and design calculations for control valves and actuators.
   a. Flow at Project design and minimum flow conditions.
   b. Pressure-differential drop across valve at Project design flow condition.
   c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
   d. Design and minimum control valve coefficient with corresponding valve position.
   e. Maximum close-off pressure.
   f. Leakage flow at maximum system pressure differential.
   g. Torque required at worst case condition for sizing actuator.
   h. Actuator selection indicating torque provided.
   i. Actuator signal to control damper (on, close or modulate).
   j. Actuator position on loss of power.
   k. Actuator position on loss of control signal.
4. Schedule and design calculations for selecting flow instruments.
   a. Instrument flow range.
   b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.

c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
d. Pressure-differential loss across instrument at Project design flow conditions.
e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

I. Sustainable Design Submittals:

1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
2. ENERGY STAR: Product Data for indicated products, showing compliance with requirements for ENERGY STAR product labeling.
3. Product Data: For adhesives and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Provide in common software formats, editable and printable (eg AutoCAD, .pdf, .doc, .xls), all text searchable. Submit both the files and printed full sized.

B. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the items described and referenced herein are shown and coordinated with each other, using input from installers of the items involved.
2. Reflected ceiling plans and other architectural details, drawn to scale, on which items are shown and coordinated with each other, using input from installers of the items involved.
3. Provide the information described above to the other disciplines for incorporating into project mechanical systems coordination drawings described in section 230500.

C. Qualification Statements:

1. Systems Provider's Qualification Data:

a. Resume of project manager assigned to Project.
b. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity, and building's primary function.
c. Description of past project DDC system, noting similarities to Project scope and complexity indicated.

2. Manufacturer's qualification data.
3. Testing agency's qualification data.

D. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
2. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks, where applicable.

E. Test and Evaluation Reports:

1. Product Test Reports: For each product, for tests performed by the manufacturer.
2. Preconstruction Test Reports: For each separate test performed.

F. Source Quality-Control Submittals:

1. Source quality-control reports.

G. Field Quality-Control Submittals:

1. Field quality-control reports.

H. Warranty of the installation, and manufacturers' warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 230500, and Division 1 specifications requiring operation and maintenance data; include the following:
   a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic and PDF formats.
   b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
   c. As-built versions of submittal Product Data.
   d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
   e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
   f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
   g. Engineering, installation, and maintenance manuals that explain how to do the following:
      1) Design and install new points, panels, and other hardware.
      2) Perform preventive maintenance and calibration.
      3) Debug hardware problems.
      4) Repair or replace hardware.
   h. Documentation of all programs created using custom programming

language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials and parts to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation following warranty period. Parts list to be indicated for each year.

C. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Reheat Air Terminal control valves with actuators, one each of the three most common Cv ratings: Three.
2. Current-Sensing Relay: One.
3. Space Temperature Sensor: Four
4. Space RH sensor: Two

1.8 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least three past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
   a. Product research and development.

b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and/or trained/licensed by, DDC system manufacturer.
2. In-place support facility located within 80 miles of Project having technical staff, parts inventory, test and diagnostic tools necessary for supporting the project.
3. Demonstrate past experience with installation of DDC system products being installed for period within three consecutive years before time of bid.
4. Demonstrate past experience on five projects of similar complexity, scope, and value.
5. Demonstrate past experience of each person assigned to Project.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support ongoing DDC system operation for a period of not less than five years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.9 WARRANTY

A. the temperature controls contractor will guarantee all components, system software and devices supplied the project against defects in material and workmanship for one year from the date of acceptance by the project manager.

1. The date of acceptance is the date upon which all software, hardware, controllers and sensors are completely installed and functioning, fully tested and demonstrated to the owner. Minor items not impacting operation, where a resolution, mutually agreed to by temperature controls contractor and construction manager, is in progress, would not delay establishing the date of acceptance.

B. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies, at no additional cost to Owner.

a. Install updates only after receiving Owner's written authorization.

3. Perform warranty service during normal business hours and commence within 24 hours of Owner's warranty service request.
4. Warranty Period: Two years from date of Acceptance of the completed and tested system in full operation.

a. For Gateway: Three year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Automated Logic Corporation
2. Delta Controls Inc
3. Honeywell International Inc.
4. KMC Controls, Inc.
5. Schneider Electric USA, Inc.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system consisting of high-speed, peer-to-peer network of distributed DDC controllers and other network devices, operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system to be web compatible.

1. Web-Compatible Access to DDC System:

a. Existing Operator Workstation and new portable workstation to perform overall system supervision and configuration, graphical user interface, management report generation, trending, and alarm annunciation.

b. DDC system to support web browser access to building data. Operator using a standard web browser is able to access control graphics and change adjustable set points.
c. Alpha-numeric plus special character password-protected web access.

2.4 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
1. DDC system for monitoring and controlling of HVAC systems.

B. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

C. Delegated Design, Qualified Professional Engineer: Engage a qualified professional engineer, as defined in Division 1, to design DDC system to satisfy requirements indicated.

D. Delegated Design, Qualified Professional: Engage a qualified professional to design DDC system to satisfy requirements indicated.
1. System Performance Objectives:
a. DDC system manages HVAC systems.
b. DDC system operates HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system responds to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system operates while unattended by an operator and through operator interaction.
e. DDC system records trends and transactions of events and produces report information such as performance, energy, occupancies, and equipment operation.

E. Surface-Burning Characteristics: Products installed complying with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

F. DDC System Speed:
1. Response Time of Connected I/O:
a. Update AI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.

b. Update BI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
c. AO points connected to DDC system to begin to respond to controller output commands within two second(s). Global commands to also comply with this requirement.
d. BO point values connected to DDC system to respond to controller output commands within two seconds. Global commands to also comply with this requirement.

2. Display of Connected I/O:

a. Update and display analog point COV connected to DDC system at least every 10 seconds for use by operator.
b. Update and display binary point COV connected to DDC system at least every 10 seconds for use by operator.
c. Update and display alarms of analog and digital points connected to DDC system within 30 seconds of activation or change of state.
d. Update graphic display refresh within eight seconds.
e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

G. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions. Minimum spare bandwidth as follows:

1. Level 1 Networks: 30.
2. Level 2 Networks: 30.
3. Level 3 Networks: 20.

H. DDC System Data Storage:

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
2. Local Storage:

a. Provide data storage capacity indicated; using IT industry standard database platforms and capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:

a. Provide application-based and web browser interfaces to configure, upload, download, and manage data and to service plan with storage adequate to store all data for term indicated. Cloud storage to use IT industry standard database platforms and is capable of functions described in "DDC Data

Access" Paragraph.

I. DDC Data Access:

1. When logged into the system, operator shall be able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system, including those provided as part of existing or new major HVAC equipment by those manufacturers.
2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

J. Future Expandability:

1. provide minimum 10% spare capacity for future point connection at each DDC control processor, of the type of spares in same proportion as the I/O functions implemented. The less than two spares of each implemented I/O type shall be provided.
2. Provide internal memory sufficient for the specified control sequences to have at least 25% of the memory needed available for future use.
3. Provide processors, communication controllers and power supplies complete and sufficient such that the implementation of additional points only requires the addition of the appropriate point I/O termination module, wiring.
4. DDC system size shall be expandable to an ultimate capacity of at least 1.5 times total I/O points indicated.
5. Design and install system networks to achieve ultimate capacity with only addition of DDC controllers, I/O, and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to remove and replace portions of network installation.
6. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.

K. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:
    a. Thermal: Within 5 percent of reading.
    b. Electric Power: Within 1 percent of reading.
    c. Requirements indicated on Drawings for meters not supplied by utility.
2. Flow:
    a. Air: Within 5 percent of design flow rate.
    b. Air Terminal Units: Within 5 percent of design flow rate.
    c. Water: Within 5 percent of design flow rate.
3. Gas:

a. Carbon Dioxide: Within 50 ppm.
b. Carbon Monoxide: Within 5 percent of reading.
c. VOCs: Within 5 percent of reading.

4. Moisture (Relative Humidity):
   a. Air: Within 5 percent RH.
   b. Space: Within 5 percent RH.
   c. Outdoor: Within 5 percent RH.
5. Level: Within 5 percent of reading.
6. Pressure:
   a. Air, Ducts and Equipment: 1 percent of instrument range.
   b. Space: Within 1 percent of instrument range.
   c. Water: Within 1 percent of instrument range.
7. Speed: Within 5 percent of reading.
8. Temperature, Dew Point:
   a. Air: Within 1 deg F.
   b. Space: Within 1 deg F.
   c. Outdoor: Within 2 deg F.
9. Temperature, Dry Bulb:
   a. Air: Within 0.5 deg F.
   b. Space: Within 0.5 deg F.
   c. Outdoor: Within 2 deg F.
   d. Chilled Water: Within 1 deg F.
   e. Heating Hot Water: Within 1 deg F.
   f. Temperature Difference: Within 0.25 deg F.
   g. Other Temperatures Not Indicated: Within 0.5 deg F.
10. Temperature, Wet Bulb:
    a. Air: Within 0.5 deg F.
    b. Space: Within 0.5 deg F.
    c. Outdoor: Within 2 deg Feg F.
11. Vibration: Within 10 percent of reading.

L. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:
   1. Current:
      a. Milliamperes: Nearest 1/100th of a milliampere.
      b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
   2. Energy:
      a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Thermal, Rate:

1) Heating: For British thermal units per hour, nearest British thermal unit per hour up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For MBh, round to nearest MBh up to 1000 MBh; nearest 10 MBh between 1000 and 10,000 MBh; nearest 100 MBh above 10,000 MBh.
2) Cooling: For tons, nearest ton up to 100 tons.

c. Thermal, Usage:

1) Heating: For British thermal unit, nearest British thermal unit up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For MBtu, round to nearest MBtu up to 1000 MBtu; nearest 10 MBtu between 1000 and 10,000 MBtu; nearest 100 MBtu above 10,000 MBtu.
2) Cooling: For ton-hours, nearest ton-hours up to 100 ton-hours.

3. Flow:

a. Air: Nearest 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm.
b. Water: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm.

4. Gas:

a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Volatile Organic Compounds (ppm): Nearest ppm

5. Moisture (Relative Humidity): Relative Humidity (Percentage): Nearest 1 percent.
6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
7. Speed:

a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:

a. Air, Ducts and Equipment: Nearest 1/10th of an inch water closet.
b. Space: Nearest 1/100th of an inch water closet.

c. Water: Nearest 1/10 of a pound per square inch gauge through 100 psig; nearest pound per square inch gauge above 100 psig.

10. Temperature:
    a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    b. Outdoor: Nearest degree.
    c. Space: Nearest 1/10th of a degree.
    d. Chilled Water: Nearest 1/10th of a degree.
    e. Heating Hot Water: Nearest degree.
11. Vibration: Nearest 1/10th of an inch per second.
12. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.

M. Control Stability: Control variables indicated within the following limits:
1. Flow:
    a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
    b. Air, Terminal Units: Within 5 percent of design flow rate.
    c. Water: Within 5 percent of design flow rate.
2. Gas:
    a. Carbon Dioxide: Within 50 ppm.
    b. Carbon Monoxide: Within 5 percent of reading.
3. Moisture (Relative Humidity):
    a. Air: Within 5 percent RH.
    b. Space: Within 5 percent RH.
    c. Outdoor: Within 5 percent RH.
4. Level: Within 5 percent of reading.
5. Pressure:
    a. Air, Ducts and Equipment: 1percent of instrument range.
    b. Space: Within 1 percent of instrument range
    c. Water: Within 1 percent of instrument range.
6. Temperature, Dew Point:
    a. Air: Within 1 deg F.
    b. Space: Within 1 deg F.
7. Temperature, Dry Bulb:
    a. Air: Within 0.5 deg F.
    b. Space: Within 0.5 deg F.
    c. Chilled Water: Within 1 deg F.
    d. Heating Hot Water: Within 1 deg F.
8. Temperature, Wet Bulb:
    a. Air: Within 1 deg F.

b. Space: Within 1 deg F.

N. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: Type 3.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated and Air-Conditioned: Type 1.
d. Hazardous Locations: Explosion-proof rating for condition.

O. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated[, cooled], and ventilated as required by instrument and application.

2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: Type 3.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 1.
d. Indoors, Heated and Air-conditioned: Type 1.
e. Hazardous Locations: Explosion-proof rating for condition.

P. DDC System Reliability:

1. Design, install, and configure DDC controllers, gateways, routers to yield a MTBF

of at least 20,000 hours, based on a confidence level of at least 90 percent. MTBF value includes any failure for any reason to any part of products indicated.

2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment being controlled, operational, and under automatic control.
3. See Drawings for critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated.

Q. Electric Power Quality:

1. Power-Line Surges:
   a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.1 and IEEE C62.41.2.
   b. Do not use fuses for surge protection.
2. Power Conditioning:
   a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:
      1) Provide isolation at all peer-to-peer network terminations, and all field point terminations, to suppress induced voltage transients.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

R. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. The operator shall have the ability to manually override any automatic or centrally executed commands at a DDC controller through a local, on-board, on/off/auto override switch for digital control type points, and gradual switches for analog control type points. This override shall be available whether the panel processor itself is operational or not.

1. Provide switches mounted within the DDC controller enclosure, provide key access to prevent unauthorized overrides.
2. DDC controllers shall have the ability to monitor and record the status of all

overrides, and inform the operator that the automatic control has been overridden.

3. DDC controllers shall record and log override activity information, available for reporting.

2.6 SYSTEM ARCHITECTURE

A. System architecture consisting of no more than two levels of LANs.

1. Level 1 LAN: Connect network controllers and operator workstations.
2. Level 2 LAN: Connect programmable application controllers to other programmable application controllers and to network controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 115,000 bps.

C. Provide dedicated and separated DDC system LANs that are not shared with other building systems and tenant data and communication networks.

D. Provide modular system architecture with inherent ability to expand to not less than 1.5 times system size indicated with no impact to performance indicated.

E. Configure architecture to minimize need to remove and replace existing network equipment for system expansion.

F. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.

G. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.

H. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling-system air-handling unit(s). Basically, create DDC system LAN that aligns with air-handling system being controlled.

2.7 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator able to access entire DDC system through any of multiple means including, but not limited to, the following:

1. Existing Desktop OWS and new portable workstation (POT) with hardwired connection through LAN port.
2. POT with hardwired connection through LAN port.
3. Mobile device and application with secured wireless connection through LAN router or cellular data service.
4. Remote connection through web access.

B. Make access to system, regardless of operator means used, transparent to operator.

C. Network Ports: For hardwired connection of desktop or POT. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:

1. Mechanical equipment room.
2. Outdoors at existing chiller.
3. Each roof-mounted equipment connected to DDC system.
4. Each VAV and each fan-powered terminal
5. Each zone space sensor.

D. Desktop Workstations:

1. Connect existing OWS to new DDC system Level 1 LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.

E. POT:

1. Connect DDC controller through a communications port local to controller.
2. Able to communicate with any DDC system controller that is directly connected or with LAN.

F. Mobile Device (Tablet and Smart Phone):

1. Connect Owner-furnished mobile devices to system through a wireless router connected to LAN and cellular data service.
2. Able to communicate with any DDC controller connected to DDC system using dedicated application and secure web access.

G. Critical Alarm Reporting:

1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.
2. Send alarm notification to multiple recipients that are assigned for each alarm.
3. Notify recipients by any or all means, including email, text message, and prerecorded phone message to mobile and landline phone numbers.

H. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any of operator interfaces indicated.

2.8 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. IP.
4. ISO/IEC/IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. IP.
4. ISO/IEC/IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.
2. CTA-709.1-D.
3. TIA 485-A.
4. IP.
5. ISO/IEC/IEEE 8802-3, Ethernet.

2.9 NETWORK COMMUNICATION PROTOCOL

A. Use network communication protocol(s) that are open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. Use ASHRAE 135 communication protocol as sole and native protocol used throughout entire DDC system.
2. DDC system to not require use of gateways except to integrate both new and existing HVAC equipment and other building systems and equipment; not required to use ASHRAE 135 communication protocol.
3. If used, gateways to connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Use operator workstations, controllers, and other network devices that are tested and listed by BTL.

2.10 SYSTEM SOFTWARE

A. Existing front-end software at the existing OWS to remain, and shall operate to the following performance requirements.

B. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system capable of operating DOS and Microsoft Windows applications.
3. Database management software to manage all data on an integrated and non-redundant basis. Additions and deletions to database are to be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software to manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software to include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software to schedule centrally based time and event, temporary, and exception day programs.

C. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity and send to printer.
6. Security Access:
    a. Use password control for operator access to DDC system.
    b. Assign an alphanumeric password (field assignable) to each operator.
    c. Grant operators access to DDC system by entry of proper password.
    d. Use same operator password regardless of which computer or other operator interface means are used.
    e. Automatically update additions or changes made to passwords.
    f. Assign each operator an access level to restrict access to data and functions the operator is cable of performing.
    g. Provide software with at least five access levels.
    h. Assign each menu item an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.

i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.

7. Operators able to perform commands including, but not limited to, the following:
   a. Start or stop selected equipment.
   b. Adjust set points.
   c. Add, modify, and delete time programming.
   d. Enable and disable process execution.
   e. Lock and unlock alarm reporting for each point.
   f. Enable and disable totalization for each point.
   g. Enable and disable trending for each point.
   h. Override control loop set points.
   i. Enter temporary override schedules.
   j. Define holiday schedules.
   k. Change time and date.
   l. Enter and modify analog alarm limits.
   m. Enter and modify analog warning limits.
   n. View limits.
   o. Enable and disable demand limiting.
   p. Enable and disable duty cycle.
   q. Display logic programming for each control sequence.
8. Reporting:
   a. Generated automatically and manually.
   b. Sent to displays, printers and disc files.
   c. Types of Reporting:
      1) General listing of points.
      2) List points currently in alarm.
      3) List of off-line points.
      4) List points currently in override status.
      5) List of disabled points.
      6) List points currently locked out.
      7) List of items defined in a "Follow-Up" file.
      8) List weekly schedules.
      9) List holiday programming.
      10) List of limits and deadbands.
9. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

D. Graphic Interface Software:
   1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items

are to be operator defined and modifiable under password control.

2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
5. Make graphic displays online user definable and modifiable using the hardware and software provided.
6. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
7. Make graphics online programmable and under password control.
8. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics to also contain software points.
10. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected to facilitate operator understanding.
11. Provide a back-trace feature to permit operator to move upward in the hierarchy using a pointing device. Back trace to show all previous penetration levels. Include operator with option of showing each graphic full-screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
14. Include operator with means to directly access graphics without going through penetration path.
15. Make dynamic data assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
18. Provide dynamic points with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, command points directly from display using pointing device.
    a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
    b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
    c. Include a keyboard equivalent for those operators with that preference.

20. Give operator ability to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot, and other information on other quadrants on screen. This feature allows real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:
    a. Online context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords and contain text and graphics to clarify system operation.
        1) If help feature does not have ability to bridge on keywords for more information, provide a complete set of user manuals in an indexed word-processing program, which runs concurrently with operating system software.
    c. Available for Every Menu Item:
        1) Index items for each system menu item.
22. Provide graphic generation software to allow operator ability to add, modify, or delete system graphic displays.
    a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols[similar to those indicated].
    b. Use a pointing device in conjunction with a drawing program to allow operator to perform the following:
        1) Define background screens.
        2) Define connecting lines and curves.
        3) Locate, orient, and size descriptive text.
        4) Define and display colors for all elements.
        5) Establish correlation between symbols or text and associated system points or other displays.

E. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
    1. Site plan showing building, and additional site elements, outdoor equipment, which are being controlled or monitored by DDC system.
    2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
        a. Room layouts with room identification and name.
        b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
        c. Location and identification of each hardware point being controlled or monitored by DDC system.

d. Locations of all sensing devices, tagged.
   1) Record exact location of hydronic piping loop differential pressure transmitters on respective system graphics
   2) exact record exact location of duct static pressure sensor and transmitter on respective system graphic
   3) identify devices above ceilings based upon nearest room location (room name/ number)

3. Control schematic for each of following, including a graphic system schematic representation[, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation summary.
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, OWS, other network devices.

F. Customizing Software:
1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. At a minimum, include the following modification capability:
   a. Operator Assignment: Designation of operator passwords, access levels, point segregation, and auto sign-off.
   b. Peripheral Assignment: Assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points, and enabling and disabling of print-out of operator changes.
   c. System Configuration and Diagnostics; Communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points, and application programs and initiation of diagnostics.
   d. System Text Addition and Change: English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time, and trouble condition.
   e. Time and Schedule Change: Time and date set, time and occupancy schedules, exception and holiday schedules, and daylight-savings time schedules.
   f. Point related change capability is to include the following:
      1) System and point enable and disable.
      2) Run-time enable and disable.

3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
4) Assignment of alarm and warning limits.

g. Application program change capability is to include the following:

1) Enable and disable of software programs.
2) Programming changes.
3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Provide software to allow operator ability to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Make additions and modifications online programmable using operator workstations, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, upload and record database on hard drive and disc for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences. Also include, at a minimum, the following:

a. Proportional control (P).
b. Proportional plus integral (PI).
c. Proportional plus integral plus derivative (PID).
d. Adaptive and intelligent self-learning control.

1) Algorithm monitors loop response to output corrections and adjust loop response characteristics in accordance with time constant changes imposed.
2) Algorithm operates in a continuous self-learning manner and retains in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

G. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display is to include the following:

a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."

b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.

5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send email alarm messages to designated operators for critical alarms.
7. Send email, page, text, and voice messages to designated operators for critical alarms.
8. Categorize and process alarms by class.
   a. Class 1:
      1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
      2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
      3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.
   b. Class 2:
      1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
      2) Acknowledgement may be through a multiple alarm acknowledgment.
   c. Class 3:
      1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
      2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
      3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
      4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.
   d. Class 4:
      1) Routine maintenance or other types of warning alarms.
      2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.

H. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Setup each report so data content, format, interval, and date are operator definable.
3. Sample and store report data on DDC controller, within storage limits of DDC controller, and then uploaded to archive on the OWS for historical reporting.
4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Store reports and logs on OWS hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Make reports and logs readily printable and set to be print either on operator command or at a specific time each day.

I. Standard Reports: Provide standard DDC system reports with operator ability to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

a. Alarm history.
b. System messages.
c. System events.
d. Trends.

J. Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.

K. HVAC Equipment Reports: Prepare Project-specific reports.

1. Chiller Report: Daily report showing operating conditions of each chiller in accordance with ASHRAE 147 including, but not limited to, the following:

a. Chilled-water entering temperature.
b. Chilled-water leaving temperature.
c. Chilled-water flow rate.
d. Times and hours for run of each compressor

e. Chiller percent load
f. Pump times and hours for run of each pump
g. Percent of full speed for each pump
h. Motor amperes per phase.
i. Motor volts per phase.
j. Ambient temperature (dry bulb and wet bulb).
k. Chiller alarms
l. Date and time logged.

2. Boiler Reports:

a. Heating hot-water entering temperature.
b. Heating hot-water leaving temperature.
c. Heating hot water flow rate.
d. Times and hours for run of each boiler
e. boiler percent load
f. Pump times and hours for run of each secondary pump
g. Percent of full speed for each secondary pump
h. Ambient temperature (dry bulb and wet bulb).
i. Boiler alarms
j. Date and time logged.

3. Zone Reports:

a. Space temperature and humidity setpoints
b. Space actual temperatures and humidity
c. Primary air flow rates
d. Reheat valve percent open
e. Any zone alarms

4. Air-Handler Reports:

a. Percent supply fan speed
b. Percent return fan speed
c. Percent economizer operation (return/outdoor air damper positions)
d. Outdoor air flow (where airflow station is applied)
e. Chilled water control valve percent open
f. Heating hot Water control valve percent open
g. Mixed air temperature
h. Heating hot water leaving air temperature
i. Unit supply air temperature

L. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Associate trends into groups, and setup a trend report for each group.
3. Store trends within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.

4. Preset trend intervals for each I/O point after review with Owner.
5. Make trend intervals operator selectable from 10 seconds up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
6. When drive storage memory is full, overwrite oldest data with most recent data.
7. Make archived and real-time trend data available for viewing numerically and graphically by operators.

M. Custom Trends: Operator-definable custom trend log for any I/O point in DDC system.

1. Include each trend with interval, start time, and stop time.
2. Sample and store data on DDC controller, within reaching 75 percent storage limits of DDC controller, and then uploaded to archive on existing OWS hard drives.
3. Make data retrievable for use in spreadsheets and standard database programs.

N. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming software is to be as follows:
    a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for DDC control systems.
        1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
        2) Make programming tools viewable in real time to show present values and logical results of each function block.
    b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
    c. Line by Line and Text Based: Programming is to declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.
5. Monitoring settings taskbar with following informational icons:
    a. Normal: Indicates by color and size, or other easily identifiable means, that all databases are within their limits.
    b. Warning: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their warning limit.
    c. Alarm: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their alarm limit.

2.11 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, air-terminal units, relief fans, and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems where indicated, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network, and vice versa, where applicable.
2. Write to all writable object properties on non-BACnet network from BACnet network, and vice versa, where applicable.
3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet, and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs in accordance with ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media with ability to modify, download, backup, and restore gateway configuration.

2.12 DDC CONTROLLERS

A. DDC system consisting of a combination of the existing JACE building controller to remain, and new programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.

C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware suitable for anticipated ambient conditions.
2. Controllers located in conditioned space rated for operation at 32 to 120 deg F temperature range.
3. Controllers located outdoors rated for operation at -20 to 150 deg F temperature range.

F. Power and Noise Immunity:

1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
    a. Network Controllers: 50 percent.
    b. Programmable Application Controllers: Not less than 60 percent.
    c. Application-Specific Controllers: Not less than 70 percent.
2. Memory for DDC controller's operating system and database are to include the following:
    a. Monitoring and control.
    b. Energy management, operation, and optimization applications.
    c. Alarm management.
    d. Historical trend data of all connected I/O points.
    e. Maintenance applications.
    f. Operator interfaces.
    g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:
    a. 20 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:
        1) AIs: Three
        2) AOs: Three.
        3) BIs: Four.
        4) BOs: Four
        5) Option to provide universal I/O to meet spare requirements.
2. Programmable Application Controllers:
    a. 20 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

1) AIs: Three.
2) AOs: Three.
3) BIs: Four.
4) BOs: Four.
5) Option to provide universal I/O to meet spare requirements.

3. Application-Specific Controllers:

a. 20 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:

1) AIs: Two.
2) AOs: two.
3) BIs: Two.
4) BOs: two.
5) Option to provide universal I/O to meet spare requirements.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. I/O Point Interface:

1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. Compatible with, and field configurable to, sensor and transmitters installed.
c. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 10 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
g. External conversion resistors are not permitted.

5. AOs:
    a. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 10 bits or better to comply with accuracy requirements indicated.
    b. Output signals range of 4 to 20 mA dc, 0 to 10 V dc, or as otherwise required to include proper control of output device.
    c. Capable of being individually calibrated for zero and span.
    d. Drift is to be not greater than 0.4 percent of range per year.
    e. External conversion resistors are not permitted.
6. BIs:
    a. Accept contact closures and ignore transients of less than 5 ms duration.
    b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
    c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
    d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
    e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.
7. BOs:
    a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.
        1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
        2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
        3) Minimum contact rating to be 1 A at 24 V ac.
        4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.
    b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
    c. BOs to be selectable for either normally open or normally closed operation.
    d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.
    e. Limit use of three-point floating devices to VAV terminal unit control applications. Control algorithms to operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.13 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Scheduling with a real-time clock to be communicated to the application controller from the existing OWS through the existing network controller.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to POT or mobile device. Local Keypad and Display:
   a. Equip controller with local keypad and digital display for interrogating and editing data.
   b. Protect use of keypad and display by security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.14 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and continued control functions without being connected to network.
2. Share data between application controllers, network controller and other network devices.

B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.

C. Operator Interface: Equip controllers with a service communications port for connection to POT or mobile device. Connection is to extend to port on space temperature sensor that is connected to controller.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.15 CONTROLLER SOFTWARE

A. General:

1. Software applications are to reside and operate in controllers. Edit applications through operator workstations or mobile devices.
2. Identify I/O points by up to 30 character point name and up to 16 character point descriptor. Use same names throughout, including at operator workstations.
3. Execute control functions within controllers using DDC algorithms.
4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Secure operator access using individual security passwords and user names.
2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
3. Record operator log-on and log-off attempts.
4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:

1. Weekly Schedule:

a. Include separate schedules for each day of week.
b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to

adjust start and stop times for each member.

2. Exception Schedules:
    a. Include ability for operator to designate any day of the year as an exception schedule.
    b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
3. Holiday Schedules:
    a. Include capability for operator to define up to 99 special or holiday schedules.
    b. Place schedules on scheduling calendar with ability to repeated each year.
    c. Operator able to define length of each holiday period.

D. System Coordination:
1. Include standard application for proper coordination of equipment.
2. Include operator with a method of grouping together equipment based on function and location.
3. Include groups that may be for use in scheduling and other applications.

E. Binary Alarms:
1. Set each binary point to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:
1. Provide each analog object with both high and low alarm limits.
2. Include capability to automatically and manually disable alarming.

G. Alarm Reporting:
1. Include ability for operators to determine action to be taken in event of an alarm.
2. Route alarms to appropriate operator workstations based on time and other conditions.
3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.

H. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

I. Control Loops:
1. Support any of the following control loops, as applicable to control required:
    a. Two-position (on/off, open/close, slow/fast) control.
    b. Proportional control.
    c. Proportional plus integral (PI) control.

d. Proportional plus integral plus derivative (PID) control.
   1) Include PID algorithms with direct or reverse action and anti-windup.
   2) Algorithm to calculate a time-varying analog value used to position an output or stage a series of outputs.
   3) Make controlled variable, set point, and PID gains operator-selectable.

e. Adaptive (automatic tuning).

J. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.

K. Anti-Short Cycling:
   1. Protect BO points from short cycling.
   2. Feature to allow minimum on-time and off-time to be selected.

L. On and Off Control with Differential:
   1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
   2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.

M. Run-Time Totalization:
   1. Include software to totalize run-times for all BI [and BO]points.
   2. Assign a high run-time alarm, if required, by operator.

2.16 ENCLOSURES

A. General:
   1. House each controller and associated control accessories in enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
   2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
   3. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
   4. Individual, wall-mounted, single-door enclosures maximum of 36 inches wide and 48 inches high.
   5. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
   6. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

7. Coordinate closely with the Construction Manager and other trades for determining locations for controls enclosures.

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electric, and electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
7. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
8. Mount products within enclosure on removable internal panel(s).
9. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). Nameplates are to have at least 1/2-inch- high lettering.
10. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
11. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
12. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Wall-Mounted, NEMA 250, Type 1:

1. NRTL listed in accordance with UL 50 or UL 50E.
2. Construct enclosure of steel, not less than the following:
    a. Enclosure Size Less Than 24 Inches: 0.053 inch thick.
    b. Enclosure Size 24 Inches and Larger: 0.067 inch thick.
3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.
4. Hinged door full size of front face of enclosure and supported using the following:
    a. Enclosures Sizes Less Than 36 Inches Tall: Multiple butt hinges.
    b. Enclosures Sizes 36 Inches Tall and Larger: Continuous piano hinges.
5. Removable internal panel with polyester powder coating that is electrostatically

applied and then baked to bond to substrate.

a. Size Less Than 24 Inches: perforated steel, 0.053 inch thick.
b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.

6. Internal panel mounting hardware, grounding hardware, and sealing washers.
7. Grounding stud on enclosure body.
8. Thermoplastic pocket on inside of door for record Drawings and Product Data.

2.17 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allen Bradley; by Rockwell Automation
b. Eaton
c. IDEC Corporation
d. Omron Americas
e. Siemens Industry, Inc., Building Technologies Division
f. Square D; Schneider Electric USA

2. NRTL listed.
3. Heavy-duty, electromechanical type; rated for at least 10A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with multiblade plug for DPDT relays and multiblade plug for three-pole double-throw relays.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a clear transparent polycarbonate dust-tight cover.
8. Include LED indication and push-to-test button to test manual operation of relay without power on coil.
9. Performance:

a. Mechanical Life: At least 10 million cycles.
b. Electrical Life: At least 100,000 cycles at rated load.
c. Pickup Time: 20 ms or less.
d. Dropout Time: 20 ms or less.
e. Pull-in Voltage: 85 percent of rated voltage.
f. Dropout Voltage: 50 percent of nominal rated voltage.
g. Power Consumption: 5 VA or less.
h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.

12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Eaton
    b. Functional Devices Inc
    c. NK Technologies
    d. Square D; Schneider Electric USA
    e. Veris Industries
2. NRTL listed.
3. Monitors ac current.
4. Independent adjustable controls for pickup and dropout current.
5. Energized when supply voltage is present and current is above pickup setting.
6. De-energizes when monitored current is below dropout current.
7. Dropout current is adjustable from 50 percent of pickup current.
8. Visual indication of contact status.
9. Include current transformer, if required for application.
10. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, Type 1 or Type 12 enclosure for indoors applications and NEMA 250, Type 4 or Type 4X for outdoor applications.

C. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Functional Devices Inc
    b. Veris Industries
2. Description:
    a. On-off control and on-off status indication in a single device.
    b. LED status indication of activated relay and current trigger.
    c. Closed-Open-Auto override switch located on the load side of relay.
3. Performance:
    a. Ambient Temperature: Minus 30 to 140 deg F.
    b. Voltage Rating: Single-phase loads rated for 300 V ac. Three-phase loads rated for 600 V ac.
4. Status Indication:
    a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.

b. Current Sensor Range: As required by application.
c. Current Set Point: Adjustable as required by application.
d. Current Sensor Output:

1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
2) Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
3) Analog, 0 to 5 or 10 V dc.
4) Analog, 4 to 20 mA, loop powered.

5. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 or Type 12 enclosure for indoor applications; NEMA 250, Type 4 or Type 4X enclosure for outdoor applications.

2.18 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional 50 percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: 40 VA.
3. Protection: Provide transformers with both primary and secondary fuses. Integral circuit breaker is acceptable in lieu of fuses.
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. DC Power Supplies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Acopian Technical Company
b. Emerson Electric Co., Automation Solutions
c. IDEC Corporation
d. Omron Americas

2. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).

a. Include both line and load regulation to ensure stable output.
b. To protect both power supply and load, include power supply with an automatic current limiting circuit.

3. Features:

a. Connection: Plug-in style suitable for mating with standard 8-pin octal socket. Include power supply with mating mounting socket.
b. Housing: Enclose circuitry in a housing.
c. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
d. Mounting: DIN rail.

e. Visual status indicator.

4. Performance:

a. Input Voltage: Nominally 120 V ac, 60 Hz.
b. Output Voltage: Nominally 24 V dc with plus or minus 1 V dc adjustment.
c. Output Current: Minimum 100 mA.
d. Load Regulation: Within 0.1 percent.
e. Line Regulation: Within 0.05 percent.
f. Stability: Within 0.1 percent of rated volts after warmup period.
g. Ripple: 1 mV rms.

2.19 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum 18 AWG.
2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum 18 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:

a. Twisted Pair: Black and white.
b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum 18 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:

a. Twisted Pair: Black and white.
b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied

with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
   1. Comply with following requirements for balanced twisted pair cable described in Division 26 specifications
      a. Plenum rated.
      b. Unique color that is different from other cables used on Project.

2.20 RACEWAYS

A. Comply with requirements in Division 26 specifications for raceway and boxes for electrical systems, for electrical power raceways and boxes.

B. Comply with requirements in Division 27 specification sections for pathways for communications systems, for raceways for balanced twisted pair cables and optical fiber cables.

2.21 ACCESSORIES

A. I/P and E/P Transducers:
   1. Commercial Grade:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) ControlAir, Inc.
         2) Dwyer Instruments, Inc
         3) KMC Controls, Inc.
         4) MAMAC Systems, Inc.
      b. Features:
         1) Auto/manual output switch, manual output control, and output pressure gauge.
         2) Separate zero and span calibration adjustments.
      c. Performance:
         1) Accuracy: Within 1.0 percent of output span.
         2) Linearity: Within 0.5 percent of output span.
         3) Vibration: Construct entire assembly so that shock and vibration will not harm transducer or affect accuracy.

2.22 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:

1. Self-adhesive label, Laminated acrylic or melamine plastic sign, bearing unique identification.
    a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size as follows:
    a. Servers: Minimum of 0.5 inch high.
    b. DDC Controllers: Minimum of 0.5 inch high.
    c. Gateways: Minimum of 0.5 inch high.
    d. Repeaters: Minimum of 0.5 inch high.
    e. Enclosures: Minimum of 0.5 inch high.
    f. Electrical Power Devices: Minimum of 0.5 inch high.
    g. Accessories: Minimum of 0.5 inch high.
    h. Instruments: Minimum of 0.5 inch.
    i. Control Damper and Valve Actuators: Minimum of 0.5 inch.
3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
4. Fastened with drive pins.
5. Instruments, control devices, and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

B. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Raceway and Boxes:

1. Comply with requirements for identification specified in Division 26 specifications Identification for Electrical Systems.

D. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.

2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least 0.25 inch beyond white border.

2.23 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate the following in accordance with industry standards for each product, and to verify DDC system reliability specified in performance requirements:

1. DDC controllers.
2. Gateways.
3. Routers.
4. Application Controllers
5. Application-specific controllers
6. Sensors and operators
7. Programming.

B. Control system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:
   1. DDC system shall be provided with communication interface for remote monitoring and/or control of/with both existing and new equipment having integral manufacturer controls for remote monitoring or control to BAS.
   2. Equipment to Be Connected:
      a. Fan-powered air-terminal units and variable air volume terminal units
      b. Boilers and associated primary and secondary pumps
      c. Chillers and associated system pumps
      d. Air-handling units outdoors
      e. Air-handling units indoors
      f. Cabinet heaters and unit heaters
      g. Exhaust and relief fans
      h. Packaged gas-electric roof-top units
      i. Ductless split heat pump units
      j. Computer-room air-conditioning units
      k. Electric resistance heaters
      l. Variable-frequency drives-speed controllers.
      m. Domestic hot water recirculation pumps.
      n. Automated glycol-feeders

3.3 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of existing and other systems/equipment integration with DDC system before developing system design and submittals:
   1. Test all communications in a controlled environment to ensure connectivity.
   2. Load software and demonstrate functional compliance with each control sequence of operation indicated.
   3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:
      a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
      b. Equipment faults and system recovery with fault annunciation.
      c. Analog and Boolean value alarming and annunciation.
   4. Develop a method for testing interfaces before deployment.
   5. Submit documentation supporting compliance upon request.
   6. Submit report on results of testing.

3.4 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. Provide Interface for BAS with existing systems to achieve integration indicated.
2. Monitoring and Control of DDC System by Existing Control System:
    a. Satisfy DDC system performance requirements when monitoring and controlling DDC system by existing control system.
    b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in DDC system from existing control system using existing control system software and operator workstations.
    c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
    d. Make interface of DDC system into existing control system transparent to operators of existing control system and allow operators to program, monitor, and control DDC system from any operator workstation connected to existing control system.
3. Provide Integration of Existing Control System into BAS System:
    a. Satisfy existing control system performance requirements when monitoring and controlling existing control system through DDC system.
    b. Operator to upload, download, monitor, alarm, report, trend, control, and program every I/O point in existing system from DDC system using operator workstations and software provided. Combined systems to share one database.
    c. Make interface of existing control system I/O points into DDC system transparent to operators. Make all operational capabilities identical regardless of whether I/O already exists, or I/O is being installed.

3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
    1. Control dampers
    2. Airflow sensors and switches
    3. Pressure sensors
    4. Temperature and humidity level air sensors

C. Deliver the following to HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
    1. Control valves.
    2. Pipe-mounted flow meters
    3. Pipe-mounted sensors, switches, and transmitters.

4. Tank-mounted sensors, switches, and transmitters.
5. Liquid temperature sensors, switches, and transmitters.
6. Pipe- and tank-mounted thermowells. Liquid thermowells.

3.6 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. Application-specific controller.
2. Electric damper actuator.
3. Unit-mounted flow and pressure sensors, transmitters, and transducers.
4. Unit-mounted temperature sensors.

3.7 GENERAL INSTALLATION REQUIREMENTS

A. Provide products to satisfy more stringent of all requirements indicated on drawings, specifications and recommendations of control manufacturers and controlled equipment manufacturers.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to force.

D. If codes and referenced standards are more stringent than requirements indicated, provide to comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Division 7 specifications

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Division 7 specifications.

H. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before

assembly.

I. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

J. Environments for accelerated degradation:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

a. Laboratory exhaust-air streams.
b. Process exhaust-air streams.
c. Outdoors.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Division 26 specification sections.
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.8 INSTALLATION OF WORKSTATIONS

A. Portable Workstation Installation:

1. Install DDC system software on new POT and verify that software functions properly.

B. Color Graphics Application:

1. Use system schematics indicated on Drawings as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Confirm final naming conventions, room names and numbers, equipment identifiers, with Owner and architect before developing graphics.
5. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
6. Seek Owner input in graphics development once using graphics software.
7. Make final editing on-site with Owner's and Architect's review and feedback.
8. Refine graphics as necessary for Owner acceptance.
9. On receiving Owner acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.9 INSTALLATION OF POT

A. Provide one POT to Owner

B. Turn over POTs to Owner at Substantial Completion.

C. Install software on each POT and verify that software functions properly.

3.10 INSTALLATION OF GATEWAYS

A. Install gateways where required for DDC system communication interface requirements indicated herein.

B. Test gateways to verify that communication interface functions properly.

C. Test routers to verify that communication interface functions properly.

3.11 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply and to UPS units where indicated.

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor for ease of access.

F. Installation of Programmable Application Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor.
4. Where Application Controllers are dedicated to equipment, install within equipment manufacturer controls cabinet enclosure.

G. Application-Specific Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.
3. Where Application-specific controllers are dedicated to terminal equipment, install within the manufacturer's controls box/enclosure.

3.12 INSTALLATION OF ENCLOSURES

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. Relays.
6. Accessories.
7. Instruments.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1] Enclosures: Use painted steel strut and hardware.
2. For NEMA 250, Type 4 or Type 4X Enclosures and Enclosures Located Outdoors: Use stainless steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top or bottom of adjacent enclosures of like size.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized-steel or stainless steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.13 ELECTRIC POWER CONNECTIONS

A. This contractor shall provide all components and devices necessary for a complete and operable DDC system as specified herein

B. Provide final electrical connections at DDC panels, connect to 120 V AC power provided by division 26 electrical contractor.

C. Each control panel shall include a dedicated circuit breaker. All 24 V power required for operation of the controls system shall be by the Temperature Controls contractor.

D. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.

E. Comply with requirements in Division 26 sections for enclosed switches and circuit breakers for electrical power circuit breakers.

F. Comply with requirements in Division 26 sections for Low-Voltage Electrical Power Conductors and Cables for electrical power conductors and cables.

G. Comply with requirements in Division 26 sections for Raceway and Boxes for Electrical Systems for electrical power raceways and boxes.

3.14 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Division 26 sections for identification for electrical systems for identification products and installation.

B. Install self-adhesive labels, laminated acrylic or melamine plastic signs, with unique identification on face for each of the following:

1. Server.
2. Gateway.
3. Router.
4. DDC controller.
5. Enclosure.
6. Electrical power device.
7. Accessory.

C. Install unique instrument identification for each instrument connected to DDC controller.

D. Install unique identification for each control damper and valve actuator connected to DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

1. Permanently attach to equipment that can be automatically started by DDC control system.
2. Locate where highly visible near power service entry points.

3.15 INSTALLATION OF NETWORKS

A. Install balanced twisted pair or optical fiber cable when connecting between the following network devices located in same building:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.

B. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:

1. Gateways.
2. Gateways and network controllers or programmable application controllers.
3. Routers.
4. Routers and network controllers or programmable application controllers.
5. Network controllers and programmable application controllers.
6. Programmable application controllers.
7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.

C. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.16 NETWORK NAMING AND NUMBERING

A. ASHRAE 135 Networks:

1. MAC Address:
   a. Assign and document a MAC address unique to its network for every network device.
   b. Ethernet Networks: Document MAC address assigned at its creation.
   c. MS/TP Networks: Assign from 00 to 64.
2. Network Numbering:
   a. Assign unique numbers to each new network.
   b. Provide ability for changing network number through device switches or operator interface.
   c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
3. Device Object Identifier Property Number:
   a. Assign unique device object identifier property numbers or device instances for each device network.
   b. Provide for future modification of device instance number by device switches or operator interface.

c. LAN is to support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field to support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

1) Example 1: Device object name for heating hot water supply temperature would be "XPL_HW_HWS_TEMP."
2) Example 2: Device object name for VAV terminal unit controller served by AHU-1 would be "AH01_TEC_RM_101."

3.17 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Division 26 specifications for Control-Voltage Electrical Power Cables.
2. Comply with installation requirements in Division 27 sections for Communications Copper Backbone Cabling.
3. Comply with installation requirements in Division 27 sections for communications Copper Horizontal Cabling.
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

a. Clamp cable over jacket in a junction box.
b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Division 26 sections for Raceway and Boxes for Electrical Systems for control-voltage conductors.

2. Comply with Division 27 sections for Pathways for Communications Systems, for balanced twisted pair cabling and optical fiber installation.

3.18 INSTALLATION OF OPTICAL FIBER CABLE SYSTEMS

A. Comply with installation requirements in Division 27 specifications for Communications Optical Fiber Backbone Cabling, and Communications Optical Fiber Horizontal Cabling.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.20 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. Control Damper Checkout:

1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment are secure.
6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

F. Control Valve Checkout:

1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that valve ball, disc, or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

G. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:
    a. Sensing element type and proper material.
    b. Length and insertion.

3.21 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
3. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.22 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.23 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator

workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.

10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.24 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests of entire BAS before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After review and approval of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. Required DDC system components, wiring, and accessories are installed.
4. Installed DDC system architecture matches approved Drawings.
5. Control electric power circuits operate at proper voltage and are free from faults.
6. DDC system network communications function properly, including uploading and downloading programming changes.
7. Each controller's programming is backed up.
8. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
9. All I/O points are programmed into controllers.
10. Testing, adjusting, and balancing work affecting controls is complete.
11. Dampers and actuators zero and span adjustments are set properly.
12. Each control damper and actuator goes to failed position on loss of power and loss of signal.
13. Valves and actuators zero and span adjustments are set properly.
14. Each control valve and actuator goes to failed position on loss of power and loss of signal.
15. Meter, sensor, and transmitter readings are accurate and calibrated.
16. Control loops are tuned for smooth and stable operation.
17. View trend data where applicable.
18. Each controller works properly in standalone mode.
19. Safety controls and devices function properly.
20. Interfaces with fire-alarm system function properly.
21. Electrical interlocks function properly.
22. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.

23. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of DDC system and sequences of operation in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
6. Submit Test Plan documentation no later than 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.
        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
5. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

3.25 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.

2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.
5.

B. Upon receipt of written request for final review, Construction Manager to start review within 10 business days and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Demonstrate operation of the DDC completed DDC system to Owner staff.
1. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
2. Demonstration to include, but not be limited to, the following:
    a. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    b. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    c. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.
    d. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    e. Trends, summaries, logs, and reports set up for Project.
    f. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    g. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
    h. Execution of digital and analog commands in graphic mode.
    i. Online user guide and help functions.
3. Communications and Interoperability: Demonstrate proper interoperability of data

sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by operator using workstation graphics, or by completing a field in menu with instructional text
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:
    a) Display of network device status.
    b) Display of BACnet object information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

3.26 EXTENDED SUPPORT

A. Operate DDC system for operating period of 28 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.

B. Provide online remote monitoring of the project to review and identify any operational problems with software or hardware for a period of two months from the point of completed startup. Report findings to the construction manager.

C. Provide technical support personnel made available for same-day response during normal business hours for emergency service on the system during the warranty period upon request from the construction manager or owner.

D. Provide to the construction manager proposed additional hourly rate for any service necessary outside of business hours.

3.27 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of completed validation testing; provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.28 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at completed validation testing, verify that service agreement includes software support for two year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

1. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.29 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.

C. Provide on-site training to Owner operating staff, up to 40 total hours: including, at minimum:

1. Project walk-through to locate control components

2. Explanation of system documents and manuals
3. Instruction on system access and navigation utilizing operator workstation and peripheral devices
4. Instruction on system operation through portable workstation and through web browser
5. Explain and demonstrate how to make adjustments, calibrations
6. Explanation of control functions through graphic interface and generating new graphics
7. Instructed on how to access and interpret trends, and how to create new trends
8. Instruction on response to alarms, how to address alarms
9. Explain how to create new schedules and sequences
10. Show how to make adjustments, calibrations.
11. Describe replacement procedures

D. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training sessions to provide Owner with at least 10 business days of notice in advance of training sessions.
3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays.

E. Attendee Training Manuals:

1. Provide each attendee with color hard copy of all training materials and visual presentations.
2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes DVD or flash drive with PDF copy of all hard-copy materials, text searchable form.

END OF SECTION 230923

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure-independent control valves.
2. Self-contained temperature-regulating valves.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Ball-style control valves.
2. Butterfly-style control valves.
3. Globe-style control valves.
4. Pressure-independent control valves.
5. Solenoid valves.
6. Electric and electronic control valve actuators.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals:

1. Schedule and design calculations for control valves and actuators, including the following:

a. Flow at project design and minimum flow conditions.
b. Pressure differential drop across valve at project design flow condition.
c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst-case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Control valve installation location indicated in relationship to room, duct, pipe, and equipment.
2. Size and location of wall access panels for control valves installed behind walls.
3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.
4. Refer to Section 230500

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

D. Code Compliance: Comply with governing energy code.

E. Delegated Design: Engage a qualified professional[engineer], as defined in Division 1 specification sections for Quality Requirements, to size products where indicated as

delegated design.

F. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

G. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

H. Selection Criteria:

1. Suitable for operation throughout full range of system operating conditions encountered.
    a. Chilled Water: Design supply temperature of 44 degrees F, return temperature of 56 degrees F, 30% mix of water and propylene glycol.
    b. Heating Hot Water: Design supply temperature of 140 degrees F, return temperature of 115 degrees F, 30% mix of water and propylene glycol..
2. Control Valve Leakage: FCI 70-2, Class IV or less leakage, unless otherwise indicated.
3. Control Valve Pattern: Straight-through 2-way, or as otherwise indicated on Drawings.
4. Control Valve Flow Characteristics, Unless Otherwise Indicated:
    a. Modulating, Two-Way Pattern: Equal percentage.
    b. Modulating Three-Way Pattern: Linear flow. Total flow through the valve to be constant regardless of the valve's position.
5. Fail-Safe Positions, Unless Otherwise Indicated:
    a. Chilled Water: Close.
    b. Heating Hot Water: Open.
6. Stable Operation: Select control valves and actuators for stable operation throughout full range of operation, from design Cv at design flow to minimum Cv.
7. Control Valve Styles:
    a. Hydronic Systems:
        1) Pipe Sizes NPS 2 (DN 50) and Smaller: Ball or globe-style control valves.
        2) Pipe Sizes Larger than NPS 2 (DN 50): Ball or globe-style control valves.

I. Sizing Criteria: Unless otherwise indicated, select control valve size using the following:

1. ISA Standards:
    a. Control Valve Sizes and Flow Coefficients: ISA 75.01.01.
    b. Control Valve Characteristics and Rangeability: ISA 75.11.01.
2. Correction Factors: Consider viscosity, flashing, and cavitation corrections when

selecting control valves.

3. Ball-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.
4. Globe-Style Control Valves: Select valve size to pass the design Cv at design flow with not more than 95 percent of stem travel.
5. Modulating Control Valves in Hydronic Systems:
    a. Select modulating control valve sizes at terminal equipment for a design Cv based on a pressure drop of 4 psig at design flow.
    b. Calculate control valve minimum Cv at 10 percent of control valve design flow, with a coincident pressure differential equal to the system design pump head.
    c. Pressure drop at design flow not to exceed 5 psig.
6. Two-Position Valves: Select two-position control valves for full pipeline size.

2.2 CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Belimo (USA), Inc
2. Bray Commercial
3. Griswold Controls, LLC
4. Honeywell Building Solutions; Honeywell International, Inc.
5. Johnson Controls, Inc.
6. Danfoss
7. Siemens
8. Caleffi

B. Source Limitations: Obtain pressure-independent ball valves, NPS 2 and smaller, from single manufacturer.

2.3 PRESSURE-INDEPENDENT CONTROL VALVES

A. Pressure-Independent Ball Valves NPS 2 (DN 50) and Smaller:

1. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Flow Characteristic: Equal percentage.
    c. Leakage: Zero.
    d. Hydronic Pressure Rating: 360 psig.
    e. Hydronic Close-off Pressure: 200 psig.
    f. Process Temperature Range: Between 35 to 250 deg F.
    g. Rangeability: 100 to 1.
2. Pressure Regulation: Control valve automatically adjusts to fluctuations in

system pressure by one of the follow methods:

a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of 5 to 50 psig pressure range.
b. Integral Electronic Regulation: Electronic flow meter and control signal to maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.
    1) Flow Measurement: Within 2 percent of actual reading.
    2) Flow Control: Within 5 percent of set point.
    3) Pressure Differential Range: 5 to 50 psig pressure range.

3. Construction:
    a. Body: Bronze or forged brass.
    b. End Connections: Female threaded (NPT) ends.
    c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
    d. Diaphragm: HNBR or EPDM.
    e. Ball: stainless steel.
    f. Seats: RTFE.
    g. Stem and Stem Extension: Material to match ball; blowout-proof design.
    h. Stem Seal: RTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.

B. Pressure-Independent Ball Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150):
1. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Flow Characteristic: Equal percentage.
    c. Leakage: Zero.
    d. Hydronic Pressure Rating: In accordance with ASME B16.1, Class 125 or 250, as required by application.
    e. Hydronic Close-off Pressure:
        1) Class 125: 175 psig.
        2) Class 250: 310 psig.
    f. Process Temperature Range: Between 35 to 250 deg F.
    g. Rangeability: 100 to 1.
2. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by one of the follow methods:
    a. Integral Mechanical Regulation: Maintains a constant pressure differential while operating within a pressure differential range of 5 to 50 psig pressure range.
    b. Integral Electronic Regulation: Electronic flow meter and control signal to

maintain flow set point regardless of system pressure variations and modulates valve based on its measured true flow.

1) Flow Measurement: Within 2 percent of actual reading.
2) Flow Control: Within 5 percent of set point.
3) Pressure Differential Range: 5 to 50 psig.

3. Construction:

a. Body: Cast iron; ASME B16.1.
b. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
c. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
d. Ball: Stainless steel.
e. Seats: RTFE.
f. Stem and Stem Extension: Material to match ball; blowout-proof design.
g. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.

C. Pressure-Independent Globe Valves with Threaded Ends:

1. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Equal percentage or linear.
c. Flow Control: Within 5 percent of set point.
d. Leakage: FCI 70-2, Class IV.
e. Hydronic Pressure Rating: 250 psig.
f. Hydronic Close-off Pressure: 90 psig.
g. Process Temperature Range: Between 35 to 240 deg F.
h. Rangeability: 50 to 1.

2. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of 5 to 60 psig

3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Bronze or forged brass.
c. End Connections: Female threaded (NPT) ends.
d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
e. Diaphragm: HNBR or EPDM.
f. O-Rings: EPDM.
g. Plug: stainless steel.
h. Spring: Stainless steel.
i. Stem: Stainless steel.

D. Pressure-Independent Globe Valves with Flanged Ends:

1. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: equal percentage or linear.
c. Flow Control: Within 5 percent of set point.
d. Leakage: FCI 70-2, Class IV.
e. Hydronic Pressure Rating: 250 psig.
f. Hydronic Close-off Pressure: 90 psig.
g. Process Temperature Range: Between 35 to 240 deg F.
h. Rangeability: 50 to 1.

2. Pressure Regulation: Control valve automatically adjusts to fluctuations in system pressure by integral mechanical regulation to maintain a constant pressure differential while operating within a pressure differential range of 5 to 60 psig.
3. Construction:

a. Size Range: NPS 2-1/2 to NPS 6.
b. Body: Cast iron or ductile iron.
c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
d. Test Ports: Two pressure and temperature test ports positioned on valve body to read pressure differential.
e. Diaphragm: HNBR or EPDM.
f. O-Rings: EPDM.
g. Plug: stainless steel.
h. Spring: Stainless steel.
i. Stem: Stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. Two-Way Applications Controlled by Flow: Pressure-Independent ball valves, Pressure-independent globe valves.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Coordinate with the mechanical contractor for the piping installer to install control valves, upon the guidance of the temperature controls contractor.

C. Install products level, plumb, parallel, and perpendicular with building construction.

D. Properly support control valves and actuators, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic event, wind, or others forces common to the application.

E. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Seal penetrations made in fire-rated and acoustically rated assemblies.

G. Fastening Hardware:

1. Wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

H. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 CONTROL VALVES

A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Drain Valves:

1. Install drain valves in piping upstream and downstream of each control valve larger than NPS 1.
2. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold.

D. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve.

E. Three-Valve Bypass Manifold: Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing isolation valves in inlet and discharge piping of control valve and a manual throttling valve in bypass pipe.

F. Valve Orientation:

1. Where possible, install valves that are installed in horizontal piping, with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping, with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access, and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt-tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Use same designation at each end for each piece of wire, cable, and tubing for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with valve identification on valve[and on face of ceiling directly below valves concealed above ceilings]. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Division 26 specification sections for Grounding and Bonding for Electrical Systems.

D. Furnish and install raceways. Comply with requirements in Division 26 specification sections for Conduits for Electrical Systems.

E. Furnish and install circuit breakers. Comply with requirements in Division 26 specification sections for Enclosed Switches and Circuit Breakers.

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Division 26 specification sections for Identification for Electrical Systems.
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Division 26 specification sections for Control-Voltage Electrical Power Cables.

D. Furnish and install raceways. Comply with requirements in Division 26 specification sections for Conduits for Electrical Systems.

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Check and document open and close cycle times for applications with a cycle time of less than 15 seconds.

C. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11

SECTION 230923.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular control dampers with airfoil blades.
2. Electric and electronic control-damper actuators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of damper and actuator:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and[mounting] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

C. Delegated Design Submittals:

1. Schedule and design calculations for control dampers and actuators, including the following:

a. Unique designation for each damper/actuator assembly.
b. Service/application.
c. Damper assembly size.
d. Damper assembly weight, including actuator(s).
e. Damper and actuator action (modulating or two position).
f. Flow at project design and minimum flow conditions.
g. Face velocity at project design and minimum airflow conditions.
h. Pressure drop across damper at project design and minimum airflow

conditions.

i. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
j. Maximum close-off pressure.
k. Leakage airflow at maximum system pressure differential (fan close-off pressure).
l. Damper torque required at worst-case condition for sizing actuator.
m. Actuator selection indicating torque provided.
n. Actuator fail-safe position on loss of power and loss of signal.
o. Remarks listing special requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Product installation location indicated in relationship to room, duct, and equipment.
2. Size and location of wall access panels for control dampers and actuators installed behind walls.
3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.
4. Refer to Section 230500.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable outdoor ventilation requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Code Compliance: Comply with governing energy code.

E. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

F. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

G. Selection Criteria:

1. Multi-Blade Damper Configuration: See Drawings:
    a. Two-Position Control: Opposed or parallel.
    b. Equipment Isolation Applications: Opposed or parallel.
    c. Outdoor/Return Air-Mixing Applications: Opposed.
    d. Modulating control: Opposed.
2. Pressure and Temperature: Control dampers suitable for operating conditions encountered by the application and following conditions unless otherwise indicated on Drawings:
    a. Up to 4” WC static pressure, air conditions from 0 degrees to 100 degrees F.
3. Fail-Safe Positions: As follows unless otherwise indicated on Drawings:
    a. Supply Air: open.
    b. Return Air: open.
    c. Outdoor Air: Close
    d. Exhaust Air: Close.
4. Select dampers with smooth and stable operation throughout full range of operation over varying pressures and temperatures encountered.
5. Sizing: See Drawings
    a. Modulating Dampers: Select damper size for a pressure drop of no more than .1 “ WC at design flow unless otherwise indicated.
    b. Two-Position Dampers: Full size of duct or equipment connection unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS WITH AIRFOIL BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
    a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.
2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe

position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Galvanized-Steel Airfoil Blades and Frames:

1. Source Limitations: Obtain rectangular control dampers, with galvanized-steel airfoil blades and frames, from single manufacturer.
2. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
3. Performance:
    a. Leakage:
        1) AMCA 511, Class 1, at 4 in. wg differential static pressure: Leakage not to exceed 8 cfm/sq. ft. against 4 in. wg differential static pressure when tested in accordance with AMCA 500D.
    b. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
4. Construction:
    a. Frame:
        1) Material: ASTM A653/A653M galvanized steel, minimum 0.06 inch thick.
        2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch for attachment to duct flanges, plenum walls, and equipment.
        3) Width: Not less than 5 inches.
    b. Blades:
        1) Configuration: Parallel or opposed blade configuration as required by application.
        2) Material: ASTM A653/A653M galvanized steel, 0.05 inch thick.
        3) Shape: Hollow, airfoil.
        4) Length: As required by close-off pressure rating, not to exceed 48 inches.
        5) Width: Not to exceed 6 inches.
    c. Seals:
        1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
        2) Jambs: Stainless steel, compression type.
    d. Axles:
        1) Diameter: Minimum 0.375 inch.
        2) Material: Plated steel.
        3) Mechanically attached to blades.

e. Bearings:
   1) Material: Molded nylon or stainless steel sleeve, as required by operating conditions, mounted in frame.
   2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:
   1) Hardware: stainless steel.
   2) Material: Plated steel or stainless steel.
   3) Mounting: Concealed in frame.

g. Transitions with Sleeve:
   1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
   2) Factory mount damper in a sleeve with a close transition to mate to field connection.
      a) Sleeve length not less than 12 inches for dampers without jackshafts and not less than 16 inches for dampers with jackshafts.
      b) Oversize damper and sleeve for duct connection size plus minimum 4 inches.
   3) Fabricate sleeve and transitions of galvanized steel.
   4) Match end connections (flange or sleeve) to field connections.

2.3 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Coordinate with equipment manufacturers for dampers integral to their equipment, and provided as part of their equipment package.

B. Select actuators to operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

C. Select actuators with sufficient power and torque to close off against the maximum system pressures encountered. Actuators are to be sized to close off against the fan shutoff pressure as a minimum requirement.

D. The total damper area operated by an actuator is not to exceed 80 percent of manufacturer's maximum area rating.

E. Provide one actuator for each damper assembly where possible. Operate multiple actuators required to drive a single damper assembly in unison.

F. Avoid the use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed

position.

G. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

H. Provide mounting hardware and linkages for connecting actuator to damper.

I. Select actuators to fail-safe in desired position in the event of a power and signal failure.

2.4 ELECTRIC AND ELECTRONIC CONTROL-DAMPER ACTUATORS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Belimo Aircontrols (USA), Inc
2. Honeywell Building Solutions; Honeywell International, Inc.
3. Johnson Controls, Inc.
4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Building Technologies Division

B. Source Limitations: Obtain electric and electronic control-damper actuators from single manufacturer.

C. Type: Motor operated, with or without gears, electric and electronic.

D. Voltage:

1. Voltage selection is delegated to professional designing control system.
2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.

E. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed-steel enclosures.
2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

F. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

G. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

H. Two-Position Actuators: Single direction, spring return or reversing type.

I. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
    a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
    b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0 to 10, or 2 to 10 V dc, and[4 to 20 mA signals.
    c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
    d. Programmable Multifunction:
        1) Control input, position feedback, and running time are to be factory or field programmable.
        2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
        3) Service data, including at a minimum, number of hours powered and number of hours in motion.

J. Position Feedback:

1. two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of position.
2. modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

K. Fail-Safe:

1. Where indicated, provide actuator to fail-safe to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

L. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.

2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

M. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and setscrew method of attachment is acceptable only if provided with at least two points of attachment.

N. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

O. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 for outdoor and unprotected applications.

P. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation[, and as follows].
    a. Operate damper from fully closed to fully open position within 15 seconds.
    b. Operate damper from fully open to fully closed position within 15 seconds.
    c. Move damper to fail-safe position within [5] [15] [30] <Insert number> seconds.
2. For actuators operating in smoke-control and other life-safety systems, comply with governing code and NFPA requirements.

Q. Sound: Where actuators are located in tenant-occupied rooms with a room sound-level criteria of NC-25 or lower, comply with the following sound levels:

1. Spring Return: 40 dBA.
2. Nonspring Return: 40 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 CONTROL-DAMPER APPLICATIONS

A. Coordinate with equipment manufacturers for dampers integral to their equipment, and provided as part of their equipment package

B. Select from damper types indicated to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

C. Rectangular Control Dampers with Insulated Blade Applications:

1. Exhaust Air: Rectangular dampers with insulated aluminum airfoil blades and thermal break frames within 10 feet of exterior opening to roof or perimeter wall.
2. Outdoor Air: Rectangular dampers with insulated aluminum airfoil blades and thermal break frames within 10 feet of exterior opening to roof or perimeter wall.
3. Return Air: Rectangular dampers with aluminum airfoil blades.
4. Supply Air: Rectangular dampers with airfoil blades.

D. Rectangular Control Dampers with Integral Airflow Applications:

1. Applications with Airflow Measurement: Rectangular dampers with aluminum airfoil blades and integral airflow measurement using pressure sensing.
2. Applications with Airflow Control: Rectangular dampers with aluminum airfoil blades and integral airflow control using pressure sensing.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Coordinate with the Mechanical Contractor to have control damper installed by sheet metal and duct systems installed, under the guidance of the temperature controls contractor.

C. Properly support dampers and actuators, tubing, wiring, and conduit to comply with

requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic, wind, or others forces common to the application.

D. Provide ceiling, floor, roof, and wall openings[, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Seal penetrations made in fire-rated and acoustically rated assemblies.

F. Fastening Hardware:

1. Wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 30 degrees, to dampers larger or smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access unless more space is recommended by manufacturer. Provide code required clearances as applicable.

C. Service Access:

1. Install dampers and actuators to be accessible for visual inspection and service.
2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions.

E. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished support alone cannot handle loading.

F. Attach field-installed actuator(s) to damper drive shaft.

G. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper[and on face of ceiling where damper is concealed above ceiling].

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Division 26 specification sections for "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Division 26 specification sections for "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Division 26 specification sections for "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Division 26 specification sections for "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and damper linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is smooth and unobstructed throughout operating range.
9. Pneumatic Control Dampers:
    a. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
    b. Verify air supply for each product is properly installed.
    c. Verify that pressure gauges are provided in each air line to damper actuator and positioner.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.12

SECTION 230923.14 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Airflow measurement stations and sensors.
2. Airflow transmitters.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Airflow measurement stations and sensors.
2. Airflow switches.
3. Airflow transmitters.
4. Liquid flow switches.

B. Product Data Submittals: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.
5. Product certificates.

C. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

6. Refer to Section 230500 – “coordination drawings”

E. Delegated Design Submittal:

1. Schedule and design calculations for flow instruments, including the following.

a. Flow at Project design and minimum flow conditions.
b. Pressure drop at Project design and minimum flow conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

B. Product Test Reports: Tests performed by a qualified testing agency.

1. Airflow measurement stations and sensors.
2. Airflow switches.
3. Airflow transmitters.
4. Liquid flow switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Air sensors and transmitters are to have an extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

B. Source Limitations: For flow instruments, obtain products from single source from single manufacturer.

2.3 AIRFLOW MEASUREMENT STATIONS AND SENSORS

A. Performance Requirements:

1. Adjustable for changes in system operational parameters.
2. Airflow Sensor and Transmitter Range: Extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions.
3. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
    a. Product certificates are required.

B. Thermal Airflow Measurement Stations:
    1. Common Performance Requirements:
        a. Provide stations that are adjustable for changes in system operational parameters.
        b. Manufacturer is to certify that each flow instrument indicated complies with specified performance requirements and characteristics.
        c. Thermal airflow stations with one or more sensor nodes mounted in a probe, and a remotely mounted microprocessor-based transmitter at each measurement location.
        d. Sensor Nodes: One self-heated and one zero-power bead-in-glass thermistor, using the principle of thermal dispersion.
        e. Airflow Rate and Temperature of Each Sensor: Equally weighted and averaged by the transmitter prior to output.
        f. Sensor-Node and Probe Assemblies:
            1) Sensor-Node Construction: Two bead-in-glass, hermetically sealed thermistors potted in a marine-grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Construct with only the thermistor located within the sensing node and all other electronic components outside the airstream. Epoxy- or glass-encapsulated chip thermistors or devices with exposed leads are not allowed. Devices that use epoxy- or glass-encapsulated chip thermistors, or electronics in the airstream, are unacceptable. Devices with exposed leads are un acceptable.
            2) Sensing-Node Temperature Accuracy: Within 0.15 deg F over an operating range of minus 20 to plus 160 deg F and humidity range of 0 to 100 percent RH.
            3) Internal Probe Wiring: Kynar-coated copper between the connecting cable and sensor nodes. PVC-jacketed wiring is unacceptable.
            4) Sensor-Probe Jacket: Integral, FEP jacket, plenum-rated CMP/CL2P, UL/cUL-listed cable, rated for exposures from minus 67 to plus 392 deg F, and for continuous and direct UV exposure. Plenum-rated PVC jacket cables are unacceptable.
        g. Transmitter Features and Functions:
            1) High and/or low airflow alarm with user-defined set point and percent of set-point tolerance.

2) Manual or automatic alarm reset, and low-limit cutoff value may be selected to disable the alarm.
3) Alarm delay function, field defined.
4) Sensor-node malfunction via the system status alarm and ignore the sensor node that is in a fault condition.
5) Field configuration, diagnostics, and field output adjustment wizard that allow for a one- or two-point field adjustment to factory calibration for installations that require adjustment.
6) Automatic reset after power disruption, transients, and brown-outs through a watchdog timer circuit.
7) Operating temperature range of minus 20 to plus 120 deg F and humidity range of 5 to 95 percent RH.
8) Electrical Power Requirement: 24 V ac (between 22.8 and 26.4 V ac under load) at 20 VA maximum, using a switching power supply that is overcurrent and overvoltage protected.
9) Printed Circuit Board Interconnects: Gold-plated edge fingers, receptacle plug pins, and printed circuit board test points.
10) Printed Circuit Boards: Electroless nickel immersion gold (ENIG) plated.
11) Integrated Circuitry: Temperature-rated, industrial-grade. Commercial-grade integrated circuitry is not acceptable.
12) Integration Buffers: Separate integration buffers for display of airflow output, airflow signal output (analog and network), and individual sensor output (IR-interface).

2. For Air-Ducted/Plenum:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Ebtron
2) Paragon Controls
3) Greenheck
4) Dwyer

b. Airflow Station Performance:

1) Independent processing of up to 16 separately wired sensor-node assemblies.
2) Accuracy: Within 3 percent of reading for ducted applications, and within 5 percent of reading for non-ducted applications, when installed in accordance with manufacturer's recommended placement guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.

c. Sensor-Node and Probe Assemblies:

1) Performance rated and tested with a 100 percent survival rate in a 30-day saltwater and acid vapor test with written independent laboratory results.
2) Sensor-Node Calibration: Individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard.
    a) Accuracy: Within 2 percent of reading over the entire calibrated airflow range of 0 to 5000 fpm.
    b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.
3) Provide the number of independent sensor nodes as follows:
    a) For Duct/Plenum Area up to 0.5 sq. ft. (0.046 sq. m): One.
    b) For Duct/Plenum Area Greater Than 0.5 through 1.0 sq. ft. (0.046 through 0.092 sq. m): Two.
    c) For Duct/Plenum Area Greater Than 2.0 through 4.0 sq. ft. (0.186 through 0.372 sq. m): Six.
    d) For Duct/Plenum Area Greater Than 4.0 through 8.0 sq. ft. (0.372 through 0.743 sq. m): Eight.
4) For an aspect ratio of 1.5 or less, and an area of 25 sq. ft. or greater, four probes are required.
5) Sensor-Probe Construction: Gold-anodized, 6063 aluminum alloy tube or Type 316 stainless steel tube, with each sensor probe containing one or more independently wired sensing nodes.

d. Transmitter:

1) Transmitter determines the average airflow rate and temperature of connected sensor nodes in an array for a single location.
2) User Interface: 16-character, alpha-numeric, LCD display, with two field-selectable analog output signals and network output capability. Provide one of the following transmitter configurations:
    a) Transmitter: Two field-selectable 0- to 5-V dc, 0-to 10-V dc, or 4- to 20-mA, scalable, isolated, overcurrent protected analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm. The RS-485 (BACnet MS/TP) network connection provides the average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.

3. For Packaged HVAC Units:

a. Airflow Station Performance

1) Independent processing of up to two separately wired sensor-node

assemblies.

2) Accuracy: Within 10 percent of reading when installed in accordance with manufacturer's recommended placement guidelines. Include the combined uncertainty of the sensor nodes and transmitter. For devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter, demonstrate compliance with the accuracy requirement over the entire operating range.

b. Sensor-Node and Probe Assemblies:

1) Sensor-Node Internal Wiring Connections: Sealed and protected from the elements and suitable for direct exposure to water. Devices with exposed leads are unacceptable.

2) Sensor-Node Calibration:

a) Individually calibrated at a minimum of seven calibration points to NIST-traceable airflow standards from 0 to 3000 fpm.

b) Individually calibrate thermistor at a minimum of three temperatures to NIST-traceable temperature standards.

3) Provide the number of independent sensor nodes as follows:

a) For a Duct Diameter of 4 Inches (102 mm): One.

b) For Duct Diameters 5 through 16 Inches (127 through 406 mm): Two.

4) Sensor-Probe Construction: Mill-finish, 6063 aluminum alloy tube, with each sensor probe containing one or more independently wired sensing nodes.

c. Transmitter:

1) Transmitter determines the average airflow rate and temperature of all connected sensor nodes in an array for a single location.

2) User Interface: An alpha-numeric, LCD display, with two field-selectable analog output signals or one isolated RS-485 (BACnet MS/TP or Modbus RTU) field-selectable network connection.

3) Model EF-A Transmitter, Analog Capability: Two field-selectable 0- to 5-V dc, 1- to 5-V dc, 0- to 10-V dc, or 2- to 10-V dc, scalable analog output signals. The first output (AO1) provides the total airflow rate. The second output (AO2) is field configurable for temperature or low and/or high airflow set-point (user-defined) or system status alarm.

4) Model EF-N Transmitter, Network Communications: RS-485 (BACnet MS/TP) network connection to provide average airflow rate, temperature, high and/or low airflow set-point alarm, system status alarm, individual sensor-node airflow rates, and individual sensor-node temperatures.

5) Contact Closure Relay: One dry contact relay with onboard jumper to drive a remote LED, rated for no less than 30 V dc or 24 V ac at 3 A maximum. User configurable as normally open or normally closed

during set up.

2.4 AIRFLOW TRANSMITTERS

A. Pressure Differential Transmitters for Airflow Measurement:

1. Performance:

a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
b. Accuracy: Within 1 percent of the full-scale range.
c. Hysteresis: Within 0.10 percent of full scale.
d. Repeatability: Within 0.05 percent of full scale.
e. Stability: Within one percent of span per year.
f. Overpressure: 10 psig.
g. Temperature Limits: Zero to 150 deg F.
h. Compensate Temperature Limits: 40 to 150 deg F.
i. Thermal Effects: 0.033 percent of full scale per degree F.
j. Shock and vibration are not to harm the transmitter.

2. Output Signals:

a. Analog Current Signal:

1) Two-wire, 4- to 20-mA dc current source.
2) Signal capable of operating into 800-ohm load.

b. Analog Voltage Signal:

1) Three wire, zero to 5, or 10 V.
2) Minimum Load Resistance: 1000 ohms.

3. Display: Four-digit digital with minimum 0.4-inch- high numeric characters.
4. Operator Interface:

a. Zero and span adjustments located behind cover.

5. Construction:

a. Plastic casing with removable plastic cover.
b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
c. Screw terminal block for wire connections.
d. Vertical plane mounting.
e. NEMA 250, Type 4.
f. Mounting Bracket: Appropriate for installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with

requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
2. Do not begin installation without submittal approval of mounting location.

E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Thermal Airflow Measurement Stations:

1. For Air-Ducted/Plenum:
    a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
    b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
2. For Air-Ducted/Plenum - Duct Size 2 sq. ft. (0.18 sq. m) or Less:
    a. Measured Velocities Less Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
    b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
3. For Supply or Return Fan Array:
    a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.

b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

4. For Supply or Return Fan, Single-Width Single-Inlet (SWSI) or Double-Width Double-Inlet (DWDI) Fans:
   a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
   b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
5. For Packaged HVAC Units:
   a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
   b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
6. For Damper-Mounted Airflow Stations:
   a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.
   b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

C. Duct-Mounted Airflow Sensors:
1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station, Thermal airflow station.

D. Damper-Mounted Airflow Sensors:
1. Measured Velocities 400 fpm (2.0 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station, Thermal airflow station.

E. Fan-Mounted Airflow Sensors:
1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube fan inlet airflow sensor station, Thermal airflow station.

F. Airflow Switches:
1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless steel single-vane switch.

G. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:
1. Air Airflow: Airflow transmitter with 0.10 percent accuracy and auto-zero feature, Pressure differential transmitter for airflow measurement, switch and controller

for airflow measurement.

H. Liquid Flow Switches:

1. Magnetic type.

I. Liquid Flow Transmitters:

1. Liquid pressure differential transmitter.

J. Refer to Section 230923, and 230993 for requirements, select features to communicate with BAS, and accomplish control intent.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <Insert value> force.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Coordinate with equipment manufacturers for airflow stations integral to their equipment.
2. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
3. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
4. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
6. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height is to comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.

    a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.6 INSTALLATION OF FLOW INSTRUMENTS

A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors are to be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service

personnel to hand clean sensors.

B. Liquid Switches:

1. Install system process connection full size of switch connection, but not less than NPS 1. Install stainless steel bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

C. Transmitters:

1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing are to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26 specification sections for Identification for Electrical Systems.

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow,

elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of

operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 230923.14

SECTION 230923.19 - MOISTURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Moisture sensors and transmitters.
2. Moisture and temperature sensors and transmitters.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Moisture switches.
2. Moisture sensors and transmitters.
3. Moisture and temperature sensors and transmitters.
4. Multifunction moisture and temperature sensors and transmitters.

B. Product Data Submittals: For each product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Product description with complete technical data, performance curves, and product specification sheets.

C. Shop Drawings:

1. Details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For moisture instruments.

PART 2 - PRODUCTS

2.1 MOISTURE SENSORS AND TRANSMITTERS

A. Moisture Sensors and Transmitters for Space Applications:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:
    a. ACI Automation; Automation Components Inc
    b. Building Automation Products Inc.; BAPI
    c. Greystone Energy Systems, Inc.
    d. Johnson Controls, Inc.
    e. MAMAC Systems, Inc.
    f. Schneider Electric USA, Inc.
    g. Siemens Industry, Inc., Building Technologies Division
    h. Telaire; a brand of Amphenol Thermometrics Inc.
2. Source Limitations: Obtain moisture sensors and transmitters for space applications from single manufacturer.
3. Description: Moisture measurement transmitter for use in space applications.
4. Performance:
    a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:
        1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):
            a) Within 2 percent relative humidity.
    b. Relative Humidity Operating Stability: Within 0.5 percent/year.
    c. Relative Humidity Range: Zero to 100 percent.
    d. Operating Temperature Range: Select for application, but not less than 32 to 122 deg F.
5. Display:
    a. Application: Sensors in spaces shall have no display.
6. Analog Output Signals: 4 to 20 mA or 0 to 5 V dc or 0 to 10 V dc
7. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
8. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity sensors.

2.2 MOISTURE AND TEMPERATURE SENSORS AND TRANSMITTERS

A. Moisture and Temperature Sensors and Transmitters for Duct Applications:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

a. ACI Automation; Automation Components Inc
b. Building Automation Products Inc.; BAPI
c. Greystone Energy Systems, Inc.
d. Honeywell Building Solutions; Honeywell International, Inc.
e. Johnson Controls, Inc.
f. MAMAC Systems, Inc]
g. Rotronic Instrument Corporation; A PST Brand
h. Schneider Electric USA, Inc.
i. Siemens Industry, Inc., Building Technologies Division
j. Telaire; a brand of Amphenol Thermometrics Inc.
k. Vaisala

2. Source Limitations: Obtain moisture and temperature sensors and transmitters for duct applications from single manufacturer.
3. Description: Moisture and temperature measurements combined in a single transmitter for use in duct and equipment applications.
4. Performance:
   a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:
      1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):
         a) Within 2 percent relative humidity.
      2) Operating Temperature Range within the Remainder of the Temperature Range Indicated:
         a) Within 2 percent relative humidity.
   b. Relative Humidity Operating Stability: Within 0.5 percent/year.
   c. Relative Humidity Range: Zero to 100 percent.
   d. Temperature Accuracy:
      1) Within 0.5 deg F accuracy over the temperature range.
      2) Within 1 deg F when operating within the remainder of the temperature range.
   e. Temperature Range: Select for application, but not less than minus 40 to plus 140 deg F.
   f. Maximum Air Velocity: As required by application, but not less than 0 to 4000 fpm.
5. Display:
   a. Application: Include transmitters with no display
6. Duct Probe: stainless steel with sintered filter
7. Analog Output Signals: Two separate signals; 4 to 20 mA, or, 0 to 5 V dc, 0 to 10 V dc.
8. Include analog output signal for relative humidity and dry-bulb temperature.
9. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.

10. Temperature Sensor: 100-ohm platinum RTD.
11. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.

B. Moisture and Temperature Sensors and Transmitters for Space Applications:

1. Description: Moisture and temperature measurements combined in a single transmitter for use in space applications.
2. Performance:
    a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:
        1) Operating Temperature Range between 32 to 104 Deg F (0 to 40 Deg C):
            a) Within 2 percent relative humidity.
        2) Operating Temperature Range within the Remainder of the Temperature Range Indicated:
            a) Within 2 percent relative humidity.
            b) Within 2 percent from 90 to 95 percent relative humidity.
    b. Relative Humidity Operating Stability: Within 0.5 percent/year.
    c. Relative Humidity Range: Zero to 100 percent.
    d. Temperature Accuracy:
        1) Within 0.5 deg F accuracy over the temperature range of 50 to 100 deg F.
        2) Within 1 deg F when operating within the remainder of the temperature range.
    e. Temperature Range: Select for application, but not less than 32 to 122 deg F.
3. Display:
    a. Application: Include transmitters with no display
4. Analog Output Signals: Two separate signals; 4 to 20 mA, or 0 to 5 V dc, or 0 to 10 V dc. Include analog output signal for relative humidity and dry-bulb temperature.
5. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
6. Temperature Sensor: 100-ohm platinum RTD.
7. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.

C. Moisture and Temperature Sensors and Transmitters for Outdoor Applications:

1. Description: Moisture and temperature measurements combined in a single transmitter for use in outdoor applications.
2. Factory Calibration: Factory calibrate each transmitter to [NIST]traceable standards and include transmitter with calibration certificate.

3. Performance:
    a. Relative Humidity Accuracy Including Non-Linearity, Hysteresis, and Repeatability:
        1) When operating within the temperature range indicated:
            a) Within 2 percent from zero to 90 percent relative humidity.
    b. Relative Humidity Operating Stability: Within 1 percent/year.
    c. Relative Humidity Range: Zero to 100 percent.
    d. Response Time: Within 20 seconds.
    e. Temperature Accuracy:
        1) Within 0.5 deg F accuracy over the temperature range of 50 to 100 deg F.
        2) Within 1 deg F when operating within the remainder of the temperature range.
    f. Temperature Range: Select for application, but not less than minus 40 to plus 140 deg F.
4. Transmitter Enclosure:
    a. Enclosure Rating: NEMA 250, Type 3R or Type 4.
5. Analog Output Signals: Two separate signals; 4 to 20 mA, or 0 to 10 V dc. Include analog output signal for relative humidity and dry-bulb temperature.
6. Humidity Sensor: Manufacturer's choice to comply with requirements indicated.
7. Temperature Sensor: Platinum RTD
8. Sensor Cables: Provide interconnecting cables, as required by the application, for transmitters located remotely from the humidity and temperature sensors.
9. Accessories: Include transmitter assembly with weather (solar radiation and precipitation) shield and mounting kit suitable for application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to external loads.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, verify that unrestricted ladder placement is possible during occupied condition.

3.3 INSTALLATION OF MOISTURE INSTRUMENTS

A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height to comply with codes and accessibility requirements.
2. Mount instruments located in mechanical equipment rooms and other similar space not subject to code, state, and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Division 26 specification sections for Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Division 26 specification sections for Boxes and Covers for Electrical Systems.

E. Furnish and install circuit breakers. Comply with requirements in Division 26 specification sections for Enclosed Switches and Circuit Breakers.

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Division 26 specification sections for Identification for Electrical Systems.
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Division 26 specification sections for Control-Voltage Electrical Power Cables.

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Division 26 specification sections for Boxes and Covers for Electrical Systems.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26 specification sections for Identification for Electrical Systems.

B. Install engraved phenolic nameplate with instrument identification on face of ceiling directly below instruments concealed above ceilings.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation that impacts performance.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE's Guideline 11, in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Switches: Calibrate switches to make or break contact at set points indicated.

E. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.[Field calibration is not required for instruments that have been factory calibrated and provided with certificates.]

3.10 DEMONSTRATION

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

and control devices.

END OF SECTION 230923.19

SECTION 230923.23 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.
4. Liquid-pressure transmitters.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.
4. Liquid-pressure switches.
5. Liquid-pressure transmitters.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and [mounting]details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details,

drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
3. Size and location of wall access panels for instruments installed behind walls.
4. Size and location of ceiling access panels for instruments installed in accessible ceilings.
5. Refer to Section 230500, Coordination Drawings

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each product requiring test performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments must operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
2. Instruments and accessories are to be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated ae to be housed in protective secondary enclosures. Instrument-installed location to dictate following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: Type 2.
    b. Outdoors, Unprotected: Type 4.
    c. Indoors, Heated with Nonfiltered Ventilation: Type 2.
    d. Indoors, Heated and Air-Conditioned: Type 1.
    e. Mechanical Equipment Rooms:

1) Air-Moving Equipment Rooms: Type 1.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Dwyer Instruments, Inc
2. Ashcroft
3. BAPI
4. Onicon (Air Monitor)
5. MAMAC Systems

2.3 AIR-PRESSURE SENSORS

A. Duct Insertion Static Pressure Sensor:

1. Insertion length to be at 4 inches.
2. Sensor with four radial holes of 0.04-inch diameter.
3. Brass construction.
4. Sensor with threaded end support, sealing washers and nuts.
5. Connection: NPS 1/4 compression fitting.
6. Suitable for flat oval, rectangular, and round duct configurations.

B. Outdoor Static Pressure Sensor:

1. Provides average outdoor pressure signal.
2. Sensor with no moving parts.
3. Kit includes sensor, vinyl tubing mounting hardware.

2.4 AIR-PRESSURE SWITCHES

A. Air-Pressure Differential Switch:

1. Diaphragm operated to actuate an SPDT snap switch.
    a. Fan safety shutdown applications: Switch with manual reset.
2. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
3. Enclosure Conduit Connection: Knock out or threaded connection.
4. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
5. High and Low Process Connections: Threaded, NPS 1/8.
6. Enclosure:
    a. Dry Indoor Installations: NEMA 250, Type 1.
    b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
    c. Hazardous Environments: Explosion proof.

7. Operating Data:
    a. Electrical Rating: 15 A at 120- to 480-V ac.
    b. Pressure Limits:
        1) Continuous: 45 inches wg.
        2) Surge: 10 psig.
    c. Temperature Limits: Minus 30 to 180 deg F.
    d. Operating Range: Approximately 2 times set point.
    e. Repeatability: Within 3 percent.
    f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Differential Transmitter:
1. Performance:
    a. Range: Approximately 2 times set point.
    b. Accuracy: Within 0.5 percent of the span at reference temperature of 70 deg F.
    c. Hysteresis: Within 0.02 percent of the span.
    d. Repeatability: Within 0.05 percent of the calibrated span.
    e. Stability: Within 0.25 percent of span per year.
    f. Overpressure: 15 psig.
    g. Temperature Limits: Minus 20 to 160 deg F.
    h. Compensate Temperature Limits: 35 to 135 deg F.
    i. Thermal Effects: 0.015 percent of full scale per degree F.
    j. Warm-up Time: Within 5 seconds.
    k. Response Time: 5 ms.
    l. Shock and vibration to not harm the transmitter.
2. Output Signals:
    a. Analog Current Signal:
        1) Two-wire, 4- to 20-mA dc current source.
        2) Signal capable of operating into 1000-ohm load.
    b. Analog Voltage Signal:
        1) Three wire, zero to 6 V.
        2) Minimum Load Resistance: 1000 ohms.
3. Operator Interface:
    a. Zero and span adjustments within 10 percent of full span.
    b. Potentiometer adjustments located on face of transmitter..

B. Air-Pressure Differential Transmitter with 0.25 Percent Accuracy and Auto Zero Feature:

1. Description:
    a. 4- to 20-mA dc output signal.
    b. NEMA 250, Type 1 enclosure.
    c. Construct assembly so shock, vibration, and pressure surges of up to 1 psig will neither harm nor affect the accuracy of the transmitter.
    d. Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit to re-zero transmitter to within 0.1 percent of true zero.
    e. Performance:
        1) Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
        2) Calibrated Span: Field adjustable, minus 40 percent of the range.
        3) Accuracy: Within 0.25 percent of natural span.
        4) Repeatability: Within 0.15 percent of calibrated span.
        5) Linearity: Within 0.2 percent of calibrated span.
        6) Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
    f. Integral digital display for continuous indication of pressure differential.

2.6 LIQUID-PRESSURE TRANSMITTERS

A. Liquid-Pressure Differential Transmitter with Field-Selectable Range:
1. Performance:
    a. Field-Selectable Ranges:
        1) 5, 10, 20 psig.
        2) 25, 50, 100 psig.
        3) 75, 150, 300 psig.
    b. Accuracy: Within 1 percent of the full-scale range.
    c. Static Pressure: 2 times full-scale range.
    d. Overpressure: Proof pressure 3 times full-scale range, burst pressure 5 times full scale.
    e. Compensate Temperature Limits: Zero to 180 deg F.
    f. Thermal Effects: 0.025 percent of full scale per degree F.
    g. Shock and vibration must not harm the transmitter.
2. Analog Output Current Signal:
    a. Two-wire, 4- to 20-mA dc current source.
    b. Signal capable of operating into 1000-ohm load.
3. Analog Output Voltage Signals:
    a. Three wire, field selectable from zero to 5 V or zero to 10 V.
    b. Minimum Load Resistance: 1000 ohms.

4. Operator Interface:
    a. Zero button located behind cover.
    b. Range selector located behind cover.
5. Provide transmitter with three-valve manifold.
    a. Construct manifold of Type 316 stainless steel.
    b. Manifold with threaded, NPS 1/4 process connections.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 PRESSURE INSTRUMENT APPLICATIONS

A. Duct-Mounted Static Pressure Sensors:
    1. Duct insertion static pressure sensor.

B. Space Static Pressure Sensors:
    1. Space static pressure sensor for wall mounting, and space static pressure sensor for recessed ceiling mounting.

C. Air-Pressure Differential Switches:
    1. Air-pressure differential switch with set-point indicator, and air-pressure

differential switch with dual scale adjustable set point, air-pressure-differential indicating.

D. Air-Pressure Differential Transmitters:

1. Duct, Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature.
2. Space, Air-pressure differential transmitter with 0.25 percent accuracy and auto zero feature.

E. Liquid Gauge Pressure Switches:

1. Liquid gauge pressure switch, diaphragm operated, low pressure.

F. Liquid-Pressure Differential Switches:

1. Liquid-pressure differential switch with set-point indicator, liquid-pressure differential switch.

G. Liquid-Pressure Differential Transmitters:

1. Liquid-pressure differential transmitter with field-selectable range.

H. Refer to Section 230923, and 230993 for requirements, select features to communicate with BAS, and accomplish control intent.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to force.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-

resistant coating that is suitable for environment.

4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Division 26 specification sections for Enclosed Switches and Circuit Breakers.

C. Furnish and install power wiring. Comply with requirements in Division 26 specification sections for "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Division 26 specification sections for "Conduits for Electrical Systems."

3.5 INSTALLATION OF PRESSURE INSTRUMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments (except pressure gauges) in liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct

static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

C. Duct Pressure Sensors:

1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately 75 percent of distance of longest hydraulic run. Location of sensors to be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

D. Outdoor Pressure Sensors:

1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
2. Locate wall-mounted sensor in an inconspicuous location.
3. Submit sensor location for approval before installation.
4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

E. Air-Pressure Differential Switches:

1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet, otherwise, locate switch in vicinity of system connection.

F. Liquid-Pressure Differential Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection to be full size of switch connection, but not less than NPS 1/2. Install stainless steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

G. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection to be full size of switch connection, but not less than NPS 1/2. Install stainless steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable,

and tubing to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.7 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.8 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration to comply with instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and

100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION 230923.23

SECTION 230923.27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air temperature sensors.
2. Air temperature switches.
3. Liquid temperature sensors, commercial grade.
4. Liquid temperature switches, commercial grade.
5. Liquid temperature transmitters, high-end commercial grade.

B. RTD: Resistance temperature detector.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Air temperature sensors.
2. Air temperature switches.
3. Liquid and steam temperature sensors, commercial grade.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation operation and maintenance instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and[mounting] details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

D. Samples: For each exposed product installed in finished space.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
3. Sizes and locations of wall access panels for instruments installed behind walls.
4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.
5. Refer to Section 230500.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
    a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated[and cooled], filtered, and ventilated as required by instrument and application.
2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
    a. Outdoors, Protected: Type 2

b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 1
d. Indoors, Heated and Air Conditioned: Type 1.
e. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
f. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
g. Hazardous Locations: Explosion-proof rating for condition.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:

1. Honeywell International Inc., Building Solutions.
2. Siemens.
3. Schneider
4. MAMAC

2.3 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common requirements:

1. 100 or 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:

a. Range: Minus 50 to 275 deg F.
b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
c. Repeatability: Within 0.5 deg F.
d. Self-Heating: Negligible.

4. Transmitter Requirements:

a. Transmitter required for each 100-ohm RTD.
b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.

B. Platinum RTD, Single-Point Air Temperature Duct Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Probe: Single-point sensor with a stainless steel sheath.
4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches long.
5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
6. Gasket for attachment to duct or equipment to seal penetration airtight.

7. Conduit Connection: 1/2-inch trade size.

C. Platinum RTD, Air Temperature Averaging Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F.
3. Multiple sensors to provide average temperature across entire length of sensor.
4. Rigid probe of aluminum, brass, copper, or stainless steel sheath.
5. Flexible probe of aluminum, brass, copper, or stainless steel sheath and formable to a 4-inch radius.
6. Length: As required by application to cover entire cross section of air tunnel.
7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
8. Gasket for attachment to duct or equipment to seal penetration airtight.
9. Conduit Connection: 1/2-inch trade size.

D. Platinum RTD Space Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 212 deg F.
3. Sensor assembly shall include a temperature sensing element mounted under a brushed-aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

E. Thermal Resistors (Thermistors): Common requirements:

1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:
    a. Range: Minus 50 to 275 deg F.
    b. Interchangeable Accuracy: At 77 deg F within 0.5 deg F.
    c. Repeatability: Within 0.5 deg F.
    d. Drift: Within 0.5 deg F over 10 years.
    e. Self-Heating: Negligible.
4. Transmitter optional, contingent on compliance with end-to-end control accuracy.

F. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:

1. 100- or 1000-ohm platinum RTD.
2. Thermistor:
    a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
    b. Thermistor drift shall be less than plus or minus 0.5 deg F over 10 years.

3. Temperature Transmitter Requirements:
    a. Mating transmitter required with each 100-ohm RTD.
    b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
4. Provide no display on sensors.
5. Provide sensor with local control only as required per sequence of perations in Section 230993.

2.4 AIR TEMPERATURE SWITCHES

1. Description:
    a. Two-position control.
    b. Field-adjustable set point.
    c. Manual reset.
    d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Performance:
    a. Operating Temperature Range: 15 to 55 deg F.
    b. Temperature Differential: 5 deg F, non-adjustable and additive.
    c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
    d. Sensing Element Maximum Temperature: 250 deg F.
    e. Voltage: 120-V ac.
    f. Current: 16 FLA.
    g. Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.
3. Construction:
    a. Vapor-Filled Sensing Element: Nominal 20 ft. long.
    b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
    c. Set-Point Adjustment: Screw.
    d. Enclosure: Painted metal, NEMA 250, Type 1.
    e. Electrical Connections: Screw terminals.
    f. Conduit Connection: 1/2-inch trade size.

B. Thermostat and Switch for High Temperature Control in Duct Applications:

1. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
2. Description:
    a. Two-position control.
    b. Field-adjustable set point.
    c. Manual reset.
    d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Performance:
    a. Temperature Range: 100 to 160 deg F.
    b. Temperature Differential: 5 deg F.
    c. Ambient Temperature: Zero to 260 deg F.
    d. Voltage: 120-V ac.
    e. Current: 16 FLA.
    f. Switch Type: SPDT snap switch.
4. Construction:
    a. Sensing Element: Helical bimetal.
    b. Enclosure: Metal, NEMA 250, Type 1.
    c. Electrical Connections: Screw terminals.
    d. Conduit Connection: 1/2-inch trade size.

2.5 LIQUID TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD, Commercial Grade:
1. Description:
    a. Platinum with a value of 100 or 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
    b. Encase RTD in a stainless steel sheath with a 0.25-inch OD.
    c. Sensor Length: 4, 6, or 8 inches as required by application.
    d. Process Connection: Threaded, NPS 1/2.
    e. Two-stranded copper lead wires.
    f. Powder-coated steel enclosure, NEMA 250, Type 4.
    g. Conduit Connection: 1/2-inch trade size.
    h. Performance Characteristics:
        1) Range: Minus 40 to 210 deg F.
        2) Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.

B. Thermowells, Commercial Grade:
1. Stem: Straight shank formed from solid bar stock.
2. Material: stainless steel.
3. Process Connection: Threaded, NPS 3/4.
4. Sensor Connection: Threaded, NPS 1/2.
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
7. Length: 4, 6, or 8 inches as required by application.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:

1. Duct, platinum RTD.
2. Outdoor, platinum RTD.
3. Space, platinum RTD.

B. Air Temperature Transmitters:

1. Duct, air temperature RTD transmitter.
2. Outdoor, air temperature RTD transmitter.
3. Space, air temperature RTD transmitter.

C. Liquid Temperature Sensors:

1. Liquid temperature sensor, high-end commercial grade.

D. Liquid and Temperature Transmitters:

1. Liquid temperature transmitter, commercial grade.

E. Refer to Section 230923, and 230993 for requirements, select features to communicate with BAS, and accomplish control intent.

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a

break in attachment when subjected to a <Insert value> force.

C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRICAL CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Division 26 specification sections for "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Division 26 specification sections for "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Division 26 specification sections for "Conduits for Electrical Systems."

3.5 INSTALLATION OF TEMPERATURE INSTRUMENTS

A. Mounting Location:

1. Roughing In:
    a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
    b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
        1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
        2) Do not begin installation without submittal approval of mounting location.
    c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    a. Make every effort to mount at 60 inches.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Installation of Space Temperature Sensor:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.

4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Installation of Outdoor Air Temperature Sensor:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Installation of Single-Point Duct Temperature Sensor:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Installation of Averaging Duct Temperature Sensor:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Installation of Low-Limit Air Temperature Switch:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Installation of Liquid Temperature Sensor:

1. Assembly shall include sensor, thermowell[and connection head].
2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4:
   a. Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
   b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
   c. Minimum insertion depth shall be 2-1/2 inches.
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor[service platform or catwalk].

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26 specification sections for "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.8 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections: Perform the following tests and inspections:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

END OF SECTION 230923.27

SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:

1. Section 230923 "DDC Systems for HVAC" for control equipment.

1.2 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

E. T: Temperature

F. adj: Setpoint adjustable by operator directly

G. PID: Proportional Integral Derivative

H. ASHRAE 36: ASHRAE Guideline 36-2021, “High-Performance Sequences of Operation for HVAC Systems”, with Appendix C.

1.3 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Proposed controls system architecture diagram, incorporating new and existing, in a relational structure.

2. Riser diagrams showing control network layout, communication protocol, and wire types.
3. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
4. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.4 HEATING HOT WATER CONTROL SEQUENCES

A. Gas-Fired Boilers: Two Existing Condensing Heating Hot Water Boilers

1. Input Device:
   a. Devices: Outdoor T, Supply Water T
   b. Transference: DDC controller.
2. Output Device:
   a. Device: DDC controller.
   b. Transference: Boiler manufacturer's Integral controls.
3. Action:
   a. Enable existing boilers through DDC controller, outdoor temperature below 70 F (adj)
   b. Disable existing boilers through DDC controller at outdoor temperature above 70F (adj)
   c. Enable existing boilers through DDC to the lowest heating stage when outdoor T is above 70 only upon a heating call from air terminal. Disable existing boilers upon end of heating call from air terminal.
   d. When enabled, cycle existing boilers to maintain supply water T to building determined by a linear reset schedule using outdoor temperature, refer to ASHRAE 36 section 5.21:
      1) Outdoor T 5F or below – supply water T of 140 F (adj)
      2) Outdoor T 65F or above – supply water T of 100 F (adj)
   e. Existing boilers shall cycle, share operating hours, establish "lead/lag" assignments through existing integral boiler manufacturer's controls.

B. Control Circulating Pump(s): Two Existing Boiler Primary

1. Input Device:
   a. Device: start/stop point.
   b. Transference: Existing boilers controllers.
2. Output Device:
   a. Device: Command to electric relay.
   b. Transference: Starter relay.

3. Action:
    a. Existing boilers' primary pumps shall be enabled to operate through existing boiler manufacturer's integral controls.
    b. Existing boiler primary pumps to be enabled whenever associated existing boiler is enabled, and disabled whenever associated existing boiler is disabled.

C. Building Circulating Pump(s): Two New Building Pumps
1. Input Devices:
    a. Device: start/stop point, water pressure differential (analog)
    b. Transference: Existing boilers controllers, DDC controller.
2. Output Device:
    a. Device: Command to relay, Analog output.
    b. Transference: VFDs
3. Action:
    a. New building pumps shall be enabled to operate through existing boiler manufacturer's integral controls.
    b. New building pumps to be enabled whenever an existing boiler is enabled, and disabled whenever both existing boilers are disabled.
    c. When enabled, building pump(s) shall maintain water pressure differential setpoint established through balancing (refer to Section 230539) by varying pump speed. Refer to ASHRAE 36 section 3.2.4.
    d. Provide reverse acting PID, per ASHRAE 36 section 5.21.

D. Boiler Alarms:
1. Action:
    a. Signal all alarm conditions from existing condensing boiler manufacturer's integral controls to OWS.

E. Circulating Pump(s) Failure Alarm:
1. Action:
    a. Signal alarm condition, no pressure differential between supply and return piping.

F. Alternate Pump(s):
1. Action: Operate pump(s) on lead-lag, alternating each startup.
2. Action: Operate pump(s) on lead-lag, alternating on 360 run hours (adj).

G. Indicate the following on the OWS:
1. DDC system graphic.
2. DDC system status, on-off.

3. Outdoor-air temperature.
4. Room temperatures.
5. Circulating pump(s) on-off status (enabled or disabled).
6. Circulating pump(s) on-off indication (operating or not operating).
7. Building circulating pump(s) pressure differential.
8. Building circulating pump(s) pressure differential set point.
9. Building circulating pump(s) on-off indication (operating or not operating).
10. Circulating pump(s) alarm pressure differential.
11. Circulating pump(s) alarm pressure differential set point.
12. Alarm (circulating pump(s) failure).
13. Building Circulating pump(s) speed pressure differential.
14. Building Circulating pump(s) speed pressure differential set point.
15. Building Circulating pump(s) speed.
16. Heating-water supply temperature to building.
17. Heating-water return temperature from building.
18. Heating-water entering and leaving temperatures at each existing boiler
19. Heating-water control-valve positions.
20. Heating-water supply temperature set point.
21. Heating-water control-point output valve.

1.5 CENTRAL CHILLED-WATER SYSTEM SEQUENCES

A. Central Chilled-Water System Time Schedule:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action:

1) Enable startup, initiation, and control.
2) Energize existing chiller and existing chilled water pumps on occupied/unoccupied cycle.
3) Enable startup outside or occupied time schedule only upon cooling call, return to unoccupied time schedule when cooling call is satisfied.
4) After chilled-water system shutdown, operate pump(s) for an additional 3 minutes (adj).

2. Display:

a. Time and time schedule.

B. Start and Stop Two Existing Chilled-Water Pump:

1. Input:
    a. Device: DDC controller.
    b. Transference: DDC controller.
2. Output:
    a. Device: Binary output.
    b. Transference: existing VFDs.
3. Action: Energize pump(s) when the chiller system is enabled, disable pumps when existing chiller system is disabled (operate pump(s) for an additional 3 minutes (adj)).
4. Display:
    a. Chilled-water flow indication.
    b. Chilled-water pump(s) on-off status (enabled or disabled).
    c. Chilled-water pump(s) on-off indication (operating or not operating).
    d. Condenser-water flow indication.
    e. Chilled-water flow indication.
    f. Chiller(s) on-off status (enabled or disabled).
    g. Chiller(s) on-off indication (operating or not operating).
    h. Chilled-water supply and return temperature.
    i. Chilled-water temperature control-point adjustment.

C. Alarm Chiller(s) Start Failure:
1. Input:
    a. Device: Software signal, Hardwired.
    b. Transference: DDC controller.
2. Output:
    a. Device: DDC controller.
    b. Transference: Operator's workstation.
3. Action: Signal alarm on signal from chiller control panel.
4. Display:
    a. Chiller "failure-to-start" indication.
    b. Chiller flow switch failure
    c. Any alarms from existing chiller’s manufacturer’s integral controller.

D. Chilled-Water Supply Temperature:
1. Input:
    a. Device: Liquid temperature sensor, with liquid temperature transmitter.
    b. Transference: DDC controller.
2. Output:
    a. Device: DDC controller signal.
    b. Transference: OWS.

3. Action: Maintain chilled-water supply temperature.
    a. Reset chilled-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:
        1) 44 deg F chilled water when outdoor-air temperature is 80 deg F or higher (adj).
        2) 48 deg F chilled-water temperature when outdoor-air temperature is 60 deg F or lower (adj).
    b. Reset chilled-water supply temperature based on maintaining a constant return chilled-water temperature of 56 deg F (adj).
    c. Reset chilled-water supply temperature in response to greatest cooling demand to maintain at least one cooling control valve 90 percent open.
    d. Utilize the lowest value result from multiple reset loops for the active chilled-water supply temperature.
    e. Refer to ASHRAE 36 section 5.20.
    f. Existing chiller will cycle compressors, condenser fans, utilizing the existing chiller manufacturer's integral controller.
4. Display:
    a. Chilled-water supply temperature.
    b. Active Chilled-water supply temperature set point.

E. Control Circulating Pump(s) Speed:
1. Input Device:
    a. Device: Liquid pressure differential transmitter.
    b. Transference: DDC controller.
2. Output Device:
    a. Device: DDC controller.
    b. Transference: Existing pump variable-speed controllers.
3. Action:
    a. When enabled, existing chilled water building pump(s) shall maintain water pressure differential setpoint established through balancing (refer to Section 230539) by varying pump speed. Refer to ASHRAE 36 section 3.2.3.
    b. Control pump speed to maintain flow through chiller (existing flow switch).
    c. Report pressure drop and flow.
    d. Report pressure drop and flow through chiller.

F. Chiller Alarms:
1. Action:
    a. Signal all alarm conditions from existing chiller manufacturer's integral controls to OWS.

G. Circulating Pump(s) Failure Alarm:

1. Action:

a. Signal alarm condition, no pressure differential between supply and return piping.
b. Existing flow switch failure

H. Alternate Pump(s):

1. Action: Operate pump(s) on lead-lag, alternating each startup.
2. Action: Operate pump(s) on lead-lag, alternating on 360 run hours (adj).

I. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system status, on-off.
3. Outdoor temperature.
4. Cooling (software) demand indication.
5. Time and time schedule.
6. Chilled-water pump(s) on-off status (enabled or disabled).
7. Chilled-water pump(s) on-off indication (operating or not operating).
8. Chilled-water pump differential pressure setpoint
9. Chilled-water pump actual differential pressure
10. Chilled-water pump(s) speed.
11. Chilled-water control-valve positions.
12. Chilled-water flow indication.
13. Refrigeration machine on-off indication (operating or not operating).
14. Chilled-water supply temperature.
15. Chilled-water return temperature.
16. Chilled-water temperature control-point adjustment.
17. Chiller(s) on-off status (enabled or disabled).
18. Chiller(s) on-off indication (operating or not operating).
19. Chiller "failure-to-start" indication.
20. Chiller(s) power input (instantaneous).
21. Chilled-water flow through chiller.
22. Chiller chilled-water supply and return temperature.
23. System capacity in tons.

1.6 AIR-HANDLING-UNIT CONTROL SEQUENCES

A. Air-Handling Unit Time Schedule:

1. Occupied Time Schedule:

a. Input:

1) Device: DDC controller.
2) Transference: DDC controller.

b. Output:

1) Device: DDC controller.

c. Action:

1) Enable startup, initiation, and control.
2) Energize unit on occupied/unoccupied cycle.
3) Energize return-air fans 30 seconds after supply fans are energized.
4) Do not enable mixed-air control during morning warm-up period.

a) Unoccupied: Position outdoor-air and relief-air dampers closed and return-air dampers open.

5) Enable control of heating coil(s) during morning warm-up period.
6) Return heating control valves to normal position when unit is cycled on.
7) Do not enable cooling-coil control during morning warm-up period.

B. Start and Stop Supply Fan(s):

1. Enable:

a. Input:

1) Device: Low limit temperature switch with automatic reset.
2) Location: Upstream of cooling coil.
3) Transference: Starter relay.

b. Output:

1) Device: Hard wired to motor controller and DDC controller.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Action:

1) Allow start if mixed air T is above 35 deg F (adj).
2) Signal alarm if fan fails to start as commanded.

2. Enable/Disable:

a. Input:

1) Device: Smoke detector with auxiliary contact manual reset.
2) Location: Mounted in air-handling unit.
3) Transference: Starter relay.

b. Output:

1) Device: Hard wired.
2) Location: Motor controller.
3) Transference: Starter relay.

c. Output Device: Hard wired through motor controller; DDC controller alarm.
d. Action:

1) Allow start if airstream is free of detected smoke.
2) Disable if smoke detector senses smoke in airstream, stop all fans,

issue alarm to DDC, Fire Alarm System (Refer to Division 28 specifications)
3) Signal alarm if fan fails to start as commanded.

C. Supply Fan(s) Variable-Volume Control:
1. Fan Speed Control:
a. Input:
1) Device: Air pressure transmitter.
2) Location: Supply-duct static pressure referenced to ambient-space static pressure.
3) Transference: DDC controller.
b. Output:
1) Device: Analog output.
2) Transference: Variable-frequency motor controller.
c. Action:
1) Maintain constant supply-duct static-pressure set point established through air balancing (refer to Section 230593). Refer to ASHRAE 36 section 3.2.
2) Set-Point Reset for Systems with DDC of Individual Zone Terminals: Reset static-pressure set point based on the zone requiring the most pressure; reset set point lower until one zone damper is nearly wide open.
3) Set variable-frequency drive to minimum speed when fan is stopped.
4) Provide following ASHRAE 36 Section 5.16
2. Fan Airflow:
a. Input:
1) Device: Airflow sensor, transmitter.
2) Location: Supply duct.
3) Transference: DDC controller.
b. Output:
1) Device: DDC controller.
c. Action: Report supply-duct airflow.
3. High Pressure:
a. Input:
1) Device: Air pressure switch.
2) Location: Supply duct, return duct, outdoor air duct, relief air duct.
3) Transference: DDC controller.
b. Output:
1) Device: Binary output; DDC controller.

2) Transference: Starter relay; operator's workstation.

c. Action: When static pressure rises above excessive + or - static-pressure set point:

1) Stop fans.
2) Signal alarm.

D. Return Fan(s) Variable-Volume Control:

1. Fan Speed Control:

a. Input:

1) Device: Airflow sensor, transmitter.
2) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: Variable-frequency drive controller.

c. Action:

1) Maintain constant airflow offset between supply- and return-air fans.
2) Set variable-frequency drive to minimum speed when fan is stopped.

2. Fan Speed Control:

a. Input:

1) Device: Air pressure sensor, differential transmitter.
2) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: Variable-frequency motor controller.

c. Action:

1) Maintain constant indoor static-pressure set point of 0.02-inch wg positive.
2) Set variable-frequency drive to minimum speed when fan is stopped.

d. Action: Maintain constant indoor static pressure.

E. Preheat Coil:

1. Freeze Protection:

a. Input:

1) Device: Air-temperature sensor RTD transmitter.
2) Location: After preheat coil.
3) Transference: DDC controller.

b. Output:

1) Device: Binary output, hard wired.

2) Transference: Starter relay.

c. Action: Stop fan and close outdoor air damper and relief air damper if temperature upstream of pre-heat coil is below 30 deg F (adj). Allow start if duct temperature is above 30 deg F (adj).

2. Supply-Air Temperature:

a. Input:

1) Device: Air-temperature sensor with air-temperature RTD transmitter.
2) Location: Discharge airstream.
3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: Control-valve actuator.

c. Action:

1) Maintain air-temperature set point of 55 deg F as cooling supply air T.
2) Provide trim-respond logic based upon outdoor air damper position, valve positions and terminal damper per ASHRAE 36 section 5.16.

F. Mixed-Air Control:

1. Minimum Position:

a. Input:

1) Device: DDC controller.
2) Transference: DDC controller.

b. Input:

1) Device: Flow measuring station.
2) Location: Outdoor-air intake.
3) Transference: DDC controller.

c. Output:

1) Device: Analog output.
2) Transference: Damper actuator(s).

d. Action:

1) Open outdoor-air dampers to minimum position.
2) Modulate outdoor-air dampers and return dampers to maintain minimum airflow at set point required for minimum ventilation, set by air balancing (refer to schedules on drawings)
3) Refer to ASHRAE 36 section 3.2.
4) Provide logic per the ASHRAE 36 section 5.16

e. Outside air economizer

1) Provide calculation sequence for determining outdoor air enthalpy is

below return air enthalpy, though limited to outdoor air drybulb temperature above 70 degrees F (adj) and a mixed air low limit temperature of 50 degrees F (adj).
2) Modulate return air damper, outdoor air damper, relief damper, relief fan speeds, in order to establish supply air temperature setpoint.
3) Operation of relief shall lag operation of return damper slightly.
4) Provide logic per ASHRAE 36 section 3.1 and 5.16

2. Setback:
   a. Input:
      1) Device: Time schedules, Space T, outdoor air T, DDC controller.
      2) Transference: DDC controller.
   b. Output:
      1) Device: Binary output, Analog output.
      2) Transference: Damper actuator(s), preheat coil valve, cooling coil valve
   c. Action: Unoccupied setback
      1) During unoccupied scheduled building hours, allow space setpoints to be relaxed by 5 degrees F.
      2) Dampers for outdoor air intake, and relief, are to be closed (return dampers full open)
      3) Utilize calculated cool-down for space to achieve occupied space T setpoints 15 minutes (adj) before scheduled occupied period start.
      4) Utilize calculated morning warm-up to achieve occupied space T setpoint 30 minutes (adj) before scheduled occupied period start.
      5) Provide calculation logic following ASHRAE 36 Section 5.4.
3. Carbon Dioxide Reset:
   a. Input:
      1) Device: Carbon dioxide transmitter.
      2) Location: Space.
      3) Transference: DDC controller.
   b. Output:
      1) Device: Analog output.
      2) Location: Dampers.
      3) Transference: Damper actuator(s).
   c. Action: Reset minimum outdoor-air damper position to maintain carbon dioxide set point of 800 (adj). Refer to ASHRAE 36 section 3.1.
   d. Provide control logic to group zones for CO2 control for each air handling unit per ASHRAE 36 section 5.2
4. Humidity Limit:
   a. Input:

1) Device: Moisture sensor and transmitter.
2) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Transference: cooling valve, air terminal heating coil valves, air terminal dampers.

c. Action:

1) Return air RH above setpoint during cooling mode, 60% RH (adj)
2) Air Handling unit is providing minimum outdoor air for ventilation.
3) Index air handling unit supply air temperature setpoint to cooling supply T of 55 degrees F.
4) Index associated air terminals for the air handler to 70% (adj) of full cooling primary damper position.
5) Return air handler supply air temperature and associated air terminal units damper positions to previous status once return air RH limit is satisfied (2% RH below limit, adj)
6) Reheat coils at associated terminal units will modulate open, as needed, independently, to maintain zone space temperature setpoint.

a) Signal high humidity alarm.
b) Record Humidity Limit mode (date/time(s), air handling unit)
c) Record terminal units utilizing reheat

G. Filters:

1. Differential Pressure:

a. Action: Signal alarm on high-pressure conditions.

H. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.

I. Indicate the following on the operator's workstation display terminal:

1. DDC system graphic.
2. DDC system on-off indication (operating or not operating).
3. DDC system occupied/unoccupied mode.
4. Outdoor-air-temperature indication.
5. Supply-fan on-off indication (operating or not operating).
6. Supply duct static-pressure indication.
7. Supply duct static-pressure set point.
8. Supply-fan airflow rate.
9. Supply-fan speed.
10. Return-fan on-off indication (operating or not operating).
11. Space static-pressure indication.
12. Space static-pressure set point.

13. Return-fan airflow rate.
14. Return-fan speed.
15. Preheat-coil air-temperature indication.
16. Preheat-coil air-temperature set point.
17. Preheat-coil control-valve position.
18. Mixed-air-temperature indication.
19. Mixed-air-temperature set point.
20. Mixed-air damper position.
21. Relative humidity indication.
22. Relative humidity set point.
23. Filter air-pressure-drop indication.
24. Filter low-air-pressure drop set point.
25. Filter high-air-pressure drop set point.
26. Supply-air-temperature indication.
27. Supply-air-temperature set point.
28. Heating-coil leaving-air-temperature indication.
29. Heating-coil leaving-air-temperature set point.
30. Heating-coil pump on-off indication (operating or not operating).
31. Heating-coil control-valve position.
32. Cooling-coil leaving-air-temperature indication.
33. Cooling-coil leaving-air-temperature set point.
34. Cooling-coil control-valve position.
35. Space temperature indication.
36. Space temperature set point.

1.7 SPACE HEATING UNITS OPERATING SEQUENCE

A. Cabinet Heater, Hydronic:

1. Space Temperature sensor:
    a. Input:
        1) Device: space sensor.
        2) Maintain space temperature setpoint of 68 F (adj)
2. Action: heating call
        1) Enable unit fan
        2) Open hot water heating coil valve
        3) When heating call is satisfied (2 degrees over setpoint), close heating coil valve, disable fan.

B. Unit Heater, Hydronic:

1. Space Temperature sensor:
    a. Input:
        1) Device: space sensor.
        2) Maintain space temperature setpoint of 60 F (adj)

2. Action: heating call
    1) Enable unit fan
    2) Open hot water heating coil valve
    3) When heating call is satisfied (2 degrees over setpoint), close heating coil valve, disable fan.

C. Radiant Heating Panel, Electric:

1. Space Temperature:
    a. Input:
        1) Device: Electronic thermostat.
        2) Location: Space.
    b. Output:
        1) Device: Low-voltage wiring.
        2) Location: Junction box.
        3) Transference: Line-voltage relay.
    c. Action: Cycle power to maintain the following space temperature set points:
        1) Occupied: 72 deg F (adj)
        2) Unoccupied building period: disabled.

1.8 SPACE TEMPERATURE MONITORING

A. Temperature:

1. Input: space T sensor, analog
2. Location: IN the following spaces:
    a. IT server room
    b. Elevator machine room
    c. Garage
3. Transference: DDC controller.
4. Output:
    a. Device: DDC controller.
5. Action: Record individual space temperatures. Alarm for individual high space temperature limit (95 degrees, adj) and alarm for individual low temperature limit (50 degrees F, adj).

1.9 VARIABLE-AIR VOLUME TERMINAL AIR UNITS, HYDRONIC REHEAT:

1. Space Temperature:
    a. Input:
        1) Device: Air-temperature sensor, transmitter.
        2) Location: Space.
        3) Transference: DDC controller.

b. Output:

1) Device: Analog output.
2) Location: Control damper and valve actuators.
3) Input Transference: Control damper and valves.

c. Action: Modulate damper and valve to maintain the following space temperature set points:

1) Occupied Cooling Temperature: 75 deg F (adj).
2) Occupied Heating Temperature: 70 deg F (adj)
3) Unoccupied Cooling Temperature: 85 deg F (adj)
4) Unoccupied Heating Temperature: 65 deg F.

d. Re-heat for space

1) Modulate primary damper actuator to minimum position.
2) When damper is at minimum position, modulate reheat coil valve from closed to open on heating call, maintain leaving air temperature setpoint.
3) If occupied space temperature is not maintained after set time (adj), modulate damper actuator from minimum position to heating position. Modulate reheat coil valve open on continued heating call.
4) If occupied space temperature is not maintained after set time (adj), modulate damper actuator from heating position to full air flow position. Modulate reheat coil valve open on continued heating call.
5) Reverse the sequence for satisfied space temperature.

e. Cooling for space

1) Modulate primary damper actuator to minimum position.
2) When damper is at minimum position, if a call for cooling occurs, modulate primary air damper to open to full open position.
3) Upon space setpoint being satisfied (less .5 degree F), modulate primary air damper back toward minimum position.

2. For Terminals with integral series fan:

a. Re-heat for space

1) Modulate primary damper actuator to minimum position.
2) Fan will be enabled during occupied time periods, operating at a constant speed set during the air balancing process.
3) When damper is at minimum position, modulate reheat coil valve from closed to open on heating call, maintain leaving air temperature setpoint.
4) If occupied space temperature is not maintained after set time (adj), modulate damper actuator from minimum position to heating position. Modulate reheat coil valve open on continued heating call.
5) If occupied space temperature is not maintained after set time (adj), modulate damper actuator from heating position to full air flow position. Modulate reheat coil valve open on continued heating call.

6) Reverse the sequence for satisfied space temperature.

b. Cooling for space

1) Modulate primary damper actuator to minimum position.
2) Fan will be enabled during occupied time periods, operating at a constant speed set during the air balancing process.
3) When damper is at minimum position, if a call for cooling occurs, modulate primary air damper to open to full open position.
4) Upon space setpoint being satisfied (less .5 degree F), modulate primary air damper back toward minimum position.

3. During unoccupied scheduled building hours, space setpoints will be relaxed. Air Terminals will perform the following sequences as part of associated air handler morning cooldown and morning warm-up modes:

a. Index terminals primary air flow dampers to full flow position, for either morning cooldown or morning warm-up modes.
b. For morning warm-up, modulate reheat coil control valve to maintain supply air temperature setpoint.
c. Utilize calculated cool-down for space to achieve occupied space T setpoints 15 minutes (adj) before scheduled occupied period start.
d. Utilize calculated morning warm-up to achieve occupied space T setpoint 30 minutes (adj) before scheduled occupied period start.
e. Provide calculation logic following ASHRAE 36 Section 5.4

4. Indicate the following on the operator's workstation display terminal:

a. DDC system graphic.
b. DDC system on-off indication (operating or not operating).
c. DDC system occupied/unoccupied mode.
d. Outdoor-air-temperature indication.
e. Cabinet Unit Heater, Hydronic:

1) Space temperature indication.
2) Space temperature set point.
3) Fan on.

f. Unit Heater, Hydronic:

1) Space temperature indication.
2) Space temperature set point.
3) Fan on.

g. Radiant Heating Panel, Hydronic:

1) Space temperature indication.
2) Space temperature set point.
3) Control-valve position.

h. Variable-Air-Volume Terminal Air Units with Hydronic Coils:

1) Space/area served.
2) Space occupied/unoccupied.

3) Space temperature indication.
4) Space temperature set point.
5) Supply air temperature setpoint
6) Actual supply air temperature
7) Primary air flow (cfm)
8) Terminal fan failure (alarm)
9) Space cooling and heating temperature set point, occupied.
10) Space cooling and heating temperature set point, unoccupied.
11) Air-damper position as percentage open.
12) Control-valve position as percentage open.

1.10 VENTILATION SEQUENCES

A. Exhaust Fan: scheduled occupancy.

1. Input:
   a. Device: DDC.
2. Output:
   a. Location: Motor controller.
   b. Transference: Starter relay.
3. Action: Enable fan on when space is occupied. Fan to be off when building is unoccupied.
4. Provide independent schedules for each exhaust fan. Exhaust fans serving rooms with mop basins will need to have an extended on/occupied period.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993.11

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, end-suction centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For each pump.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators[and seismic restraints] and for designing vibration isolation bases.

b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: [One] <Insert number> mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[and seismic restraints].

C. Seismic Performance: Pumps shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified
2. Component Importance Factor: 1.0.

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Bell & Gossett (Xylem)
2. Armstrong Fluid Technology
3. Grundfos Pumps Corporation
4. Peerless Pump Company
5. Taco Comfort Solutions

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

D. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and flanged connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: Type 304 stainless steel.
4. Pump Stub Shaft: Type 304 stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket. Include water slinger on shaft between motor and seal.

E. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure: drip-proof premium efficiency.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Inverter duty motor with grounding for protection of bearings, intended for use with variable frequency speed drives.

F. Capacities and Characteristics:

1. Capacity: refer to schedules on plans
2. Electrical Characteristics:

a. Volts: 208 V.
b. Phase: Three.
c. Hertz: 60 Hz.

2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Bell & Gossett (Xylem)
2. Armstrong Fluid Technology
3. Grundfos Pumps Corporation
4. Peerless Pump Company
5. Taco Comfort Solutions

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

D. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Type 304 stainless steel.
4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket.
5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve for variable-speed applications.

F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure: drip-proof premium efficiency.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Inverter duty motor with grounding for protection of bearings, intended for use with variable frequency speed drives.
6. Capacities and Characteristics:
7. Capacity: refer to schedules on plans

I. Electrical Characteristics:

1. Volts: 208 V.
2. Phase: Three.
3. Hertz: 60 Hz.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and type 304 stainless steel permanent strainers with 3/16-inch.
4. Type 304 stainless steel] straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations, refer to Division 3 specifications.
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

D. Comply with pump and coupling manufacturers' written instructions.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install suction diffuser and shutoff valve on suction side of pumps.

1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

F. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

G. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Division 26 specifications for "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Division 26 specifications for "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 specifications for "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 specifications for "Control-Voltage Electrical Power Cables."

C. Refer to section 230923 and 230993 for controls, communication and sequences.

D. Refer to section 232923 for variable frequency drives

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to assist in startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to assist in test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Hydronic pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to assist in training of Owner's

maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following HVAC water-treatment systems:

1. Manual and automatic chemical-feed equipment and controls.
2. Chemical-treatment test equipment.
3. Chemicals.

1.2 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. PPM: Parts per million.

C. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

D. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. TDS controllers.
3. TSS controllers.
4. Chemical solution tanks.
5. Injection pumps.
6. Chemical test equipment.
7. Chemical material safety data sheets.
8. Inhibited propylene glycol.
9. Multimedia filters.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For chemical-treatment and equipment from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and

locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

E. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, water-filtration and controllers to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 HVAC WATER-TREATMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Aqua-Chem, Inc.
2. Barclay Water Management, Inc
3. Earthwise Environmental Inc
4. Nalco; an Ecolab company
5. Chardon Labs
6. Watcon, Inc

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum

efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating, chilled water with mix of water and propylene glycol; shall be brought within appropriate industry standards, and as required by equipment manufacturers served by the systems, for the following qualities:

1. pH:
2. Alkalinity:
3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion. Maintain soluble iron concentrations at or below limits.
4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion. Maintain soluble copper concentrations at or below limits.
5. Scale Control: Provide softened water for initial fill and makeup. Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
7. Microbiological Limits:
    a. Total Aerobic Plate Count: Maintain value of organisms below limits.
    b. Total Anaerobic Plate Count: Maintain value of organisms below limits.
    c. Nitrate Reducers: Maintain a value of organisms below limits.
    d. Sulfate Reducers: Maintain a value of organisms below limits.
    e. Iron Bacteria: Maintain a value of organisms below limits.
    f. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <Insert value> mils per year. Maintain soluble copper concentrations at or below <Insert value> mg/L.
    g. Ammonia: Maintain a value of <Insert number> mg/L.
    h. <Insert other requirements if necessary>.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Programmable timers with infinite adjustment over full range, mounted in cabinet

with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

B. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal..

C. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230500"
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints, except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.

E. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

B. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.

2.5 INHIBITED PROPYLENE GLYCOL

A. Inhibited Propylene Glycol:

1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
3. Operating Temperature Range: minus 50 deg F to 250 deg F
4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to minus 20 deg F (approximately 30%). Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

B. Perform an analysis of existing heating hot water and chilled water in the existing closed loops to determine present conditions. Report findings to construction manager.

3.2 CLEANING

A. Perform cleaning and flushing of existing system piping and equipment to remain to prepare the system for connection of new equipment and distribution piping.

1. Select detergents and rinse agents specifically for the systems, based upon findings from the initial water analysis.
2. They system shall be cleaned with detergent per manufacturer’s recommendation, rinsed. Allow detergents to remain in system as needed for effective cleaning.
3. Repeat cleaning and flush. Flush to clear.

3.3 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.

B. Install water-testing equipment on wall near water-chemical-application equipment.

C. Install interconnecting control wiring for chemical-treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Install automatic fluid make-up equipment for glycol water system and include the following:

1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.
4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

3.4 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

3.5 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

B. Ground equipment in accordance with Division 26 specifications for "Grounding and

Bonding for Electrical Systems."

C. Connect wiring in accordance with Division 26 specifications for "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

E. Equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for chilled-water piping and heating, hot-water piping and associated equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to assist in training Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment. When training is complete, turn over video to Owner for future use.

END OF SECTION 232500

SECTION 232923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. CE: (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and

size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.
5. Refer to Section 230500 for Coordination Drawings

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 specification sections for Operation and Maintenance Data, include the following:

a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.

b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in heated and cooled space indoors, inside original manufacturer packaging, prevent damage and maintain units clean, until installed.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1. ABB, Electrification Business

2. Eaton
3. Nidec Motor Corporation; Nidec Corporation
4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Building Technologies Division
6. Yaskawa Electric America, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A, UL 61800 standard.

B. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

C. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

E. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load

or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.35 times the base load current for two seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

F. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

G. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

H. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

I. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, coordinated AC transient type, 4 MOVs, capacitor clamp and internal chokes
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.

11. Motor-overtemperature fault.

J. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip, molded-case switch, with power fuse block and current-limiting fuses, pad-lockable disconnect with door-handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. NC alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.

3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
    a. A minimum of two programmable analog inputs: 0- to 10-V dc, 4- to 20-mA dc (operator-selectable),
    b. A minimum of six multifunction programmable digital inputs.

2. Remote input signal, through digital input, to start and stop controlled equipment with remote low voltage toggle switch installed inn occupied space, powered from VFD control circuit.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
    a. 0- to 10-V dc.
    b. 4- to 20-mA dc.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
4. Output Signal Interface: A minimum of two programmable analog output signal(s) 0- to 10-V dc, 4- to 20-mA dc (operator-selectable) which can be configured for any of the following:
    a. Output frequency (Hz).
    b. Output current (load).
    c. DC-link voltage (V dc).
    d. Motor torque (percent).
    e. Motor speed (rpm).
    f. Set point frequency (Hz).
5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    a. Motor running.
    b. Set point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
    1. Number of Loops: Two.

G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
    1. Hardwired Points:
        a. Monitoring: On-off status
        b. Control: On-off operation
    2. Communication Interface: Comply with ASHRAE 135 (MS-TP). Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the

DDC system for HVAC.

3. Refer to Section 230923 and 230993, for requirements, select features to communicate with BAS, and accomplish control intent.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. EMI/RFI Filtering:

1. CE marked; certify compliance with IEC 61800-3.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode:

1. Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller:

1. Two-Contactor-Style Bypass: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode].
   a. Bypass Contactor: Load-break, IEC rated contactor.
   b. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
6. Overload Relays: NEMA ICS 2.
    a. Bimetallic Overload Relays:
        1) Inverse-time-current characteristic.
        2) class 10 tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
        4) Ambient compensated.
        5) Automatic resetting.
    b. NC isolated overload alarm contact.
    c. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

B. Remote digital operator kit.

C. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a notebook computer.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
    1. Dry and Clean Indoor Locations: Type 1 <Insert type>.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Unguarded.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Cooling Fan and Exhaust System: For NEMA 250, Type 1, UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 V ac; obtained from integral CPT.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

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

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 specification section for Hangers and Supports for Electrical Systems.

B. Seismic Bracing: Comply with requirements specified in Division 26 specification section for "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFC.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 specification section for "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices[and facility's central-control system]. Comply with requirements in Division 26 specification section for "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 specification section for "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to assist with startup service.

1. Complete installation and startup checks according to manufacturer's written instructions. Submit reports for acceptance to construction manager

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times,

allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 specification section for "Coordination Studies."

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 232923

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.
6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections,

components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom]of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, for selecting hangers and supports and any required seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans, generated with electronic drafting software (AutoDesk) or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Refer to Section 230500.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Provide work in accordance with Ohio Mechanical Code 2017, and Authority Having Jurisdiction.

B. Provide work per The Sheet Metal and Air Conditioning Contractors' National Association, SMACNA, standards:

1. HVAC Duct Construction Standards – Metal and Flexible, 4th Ed.
2. HVAC Air Duct Leakage Test Manual, 2nd Ed.
3. IAQ Guidelines for Occupied Buildings Under Construction, 2nd Ed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports[and seismic restraints] are to withstand the effects of gravity and seismic loads, where required, and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7,where required.

C. Seismic Performance: Ductwork to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7, See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."
2. Component Importance Factor: 1.0.

D. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

G. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation, duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Ductmate Industries, Inc; a DMI company
2. McGill AirFlow LLC
3. MKT Metal Manufacturing
4. SHAPE Manufacturing Inc]
5. Sheet Metal Connectors, Inc.

B. Source Limitations: Obtain double-wall rectangular ducts and fittings from single manufacturer.

C. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

E. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's

"HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

F. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.

G. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F conductivity at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

H. Interstitial Insulation, Flexible Elastomeric: Duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F conductivity at 75 deg F mean temperature.

I. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

2.4 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's

"HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 48 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Linx Industries; a DMI company (formerly Lindab)
2. McGill AirFlow LLC
3. MKT Metal Manufacturing
4. SEMCO, LLC; part of FlaktGroup
5. SPOT
6. Set Duct Manufacturing
7. SHAPE Manufacturing Inc.
8. Sheet Metal Connectors, Inc

B. Source Limitations: Obtain double-wall round[and flat oval] ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Transverse Joints in Ducts Larger Than 48 Inches in Diameter: Flanged.
3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

F. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity:0.27 Btu x in./h x sq. ft. x deg F conductivity at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: [Black] [White].
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

2.7 DUCT LINER

A. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:
   a. Acoustical Surfaces, Inc.
   b. Ductmate Industries, Inc; a DMI company
   c. Johns Mansville
   d. Nomaco
   e. Knauf
2. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single

manufacturer.

3. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
5. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    a. Adhesive shall have a VOC content of 80 g/L or less.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
8. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
10. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
11. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Where ductwork is exposed to public view in finished specs, duct hangers shall be single and double rod connection point band type hangers for round and flat-oval applications, continuous galvanized steel band, minimum 2” wide and minimum 14 ga material, tightly formed to specific cross-section contour of all ducts.

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

L. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. Where ductwork is exposed to public view in finished specs, duct hangers shall be single and double rod connection point band type hangers for round and flat-oval applications, continuous galvanized steel band, locking nuts and threaded rod on top where less noticeable to occupants, paint ready.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
3. Conditioned Space, 2-inch WC or less, Supply-Air Ducts Seal Class B.
4. Conditioned Space, Exhaust Ducts: Seal Class B.
5. Exhaust duct pressure over 2” WC Seal Class A.
6. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.
6. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports, trim excess rod and file smooth, within 1-1/2”.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.6 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for

branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in specification sections in Division 9 for Painting.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
    a. Ducts with a Pressure Class Higher Than 4-Inch wg: Test all duct sections.
    b. Ducts with a Pressure Class of 4 Inch wg or less: Test representative duct sections totaling no less than 50 percent of total installed duct area.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven business days advance notice to construction manager for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system(s) where cleanliness test is not accepted, before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being

cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.10 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Variable-Air-Volume Air-Handling Units <Insert equipment>:

a. Pressure Class: Positive 4 inch wg.
b. Minimum SMACNA Seal Class: B.

C. Return Ducts:

1. Ducts Connected to Air-Handling Units

a. Pressure Class: Positive or negative 3 inch wg.
b. Minimum SMACNA Seal Class: C.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2 inch wg.
b. Minimum SMACNA Seal Class: C if negative pressure, and B if positive pressure.

2. Ducts Connected to Fans Exhausting Fumes (ASHRAE 62.1, Class 3 and Class

a. Pressure Class: Positive or negative 6 inch wg.
b. Minimum SMACNA Seal Class A.

E. Outdoor-Air Ducts:

1. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 3 inch wg.
b. Minimum SMACNA Seal Class: B.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

G. Liner:

1. Return-Air Ducts: Fibrous-glass-free, natural fiber, 1 inch thick.
2. Transfer Ducts: Fibrous-glass-free, natural fiber, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"

Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 10 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 12 Inches and Larger in Diameter: Standing seam or welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees."

a. Velocity to 1500 fpm: Conical tap.
b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Flange connectors.
5. Duct silencers.
6. Flexible connectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of

the items involved. Refer to Section 230500.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Performance:
    a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
2. Construction:
    a. Linkage out of airstream.
    b. Suitable for horizontal or vertical airflow applications.
3. Frames:
    a. Hat-shaped, 16-gauge- thick, galvanized sheet steel
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized steel; 16 gauge thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
    a. Molded synthetic or stainless steel sleeve.
    b. Dampers mounted with vertical blades to have thrust bearing at each end

of every blade.

7. Tie Bars and Brackets: Galvanized steel.
8. Locking device, with graduation marking scale, to hold damper blades in a fixed position without vibration.

B. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

A. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and opposed blade for modulating and positioning, such as when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.
3. Refer to Section 230923.12 “Control Dampers”.

B. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
    a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
    b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
    c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
    d. Class III: Leakage shall not exceed 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Temperature: Minus 25 to plus 180 deg F.
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a

maximum blade deflection of 1/200 of blade length.

C. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
   a. Hat, U, or angle shaped.
   b. 0.08-inch- thick extruded aluminum or 16-gauge- thick, galvanized sheet steel.
   c. Mitered and welded, or Interlocking, gusseted corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
   a. Multiple blade with maximum blade width of 6 inches.
   b. Galvanized steel or Aluminum.
   c. 16-gauge- thick single skin.
5. Blade Edging Seals:
   a. Replaceable Closed-cell neoprene
   b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
   a. Molded synthetic or stainless steel sleeve.
   b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

A. Type: Static; rated and labeled in accordance with UL 555 by an NRTL.

B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

C. Fire Rating: according to rating of building element where applied.

D. Frame: Curtain type with blades outside airstream, fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed galvanized sheet steel, interlocking, full-length steel blade connectors. Material gauge is to be in accordance with UL listing.

H. Horizontal Dampers: Include blade lock and stainless steel closure spring.

I. Heat-Responsive Device:

1. Replaceable, temperature rated, fusible links.

2.5 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.6 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work:

1. FläktGroup
2. Flexmaster U.S.A., Inc
3. IAC Acoustics
4. McGill AirFlow LLC
5. Metal Form Manufacturing LLC; United Enertech Corp
6. Price Industries Limited
7. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
8. Vibro-Acoustics

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.

3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A653/A653M, G90 galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22 gauge thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20 gauge thick.

F. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 22 gauge thick, and with 1/8-inch diameter perforations.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Film-lined type with fill material.
    a. Fill Material: Inert and vermin-proof moisture-proof nonfibrous material.
    b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.
3. Lining: none.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Lock formed and sealed or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.
2. Removable splitters.
3. Airflow-measuring devices.

L. Source Quality Control:

1. Test in accordance with ASTM E477.
2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

M. Capacities and Characteristics:

1. Configuration: Straight.
2. Shape: Rectangular, or Round.
3. Attenuation Mechanism: Acoustical non-fiberous.
4. Maximum Pressure Drop: 0.30 inch wg at design air flow
5. Casing:
    a. Attenuation: Standard.
6. End Connection: 1-inch slip joint or Flange.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install [backdraft] [control] dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire[and smoke] dampers in accordance with UL listing.

I. Connect ducts to duct silencers rigidly.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream[and downstream] from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-ft.spacing.
8. Upstream[and downstream] from turning vanes.
9. Upstream or downstream from duct silencers.
10. For grease ducts, install at locations and spacing as required by NFPA 96.
11. Control devices requiring inspection.
12. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

M. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible ducts, insulated.
2. Flexible duct connectors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Flexible ducts, insulated.

B. Product Data Submittals: For each type of product.

C. Shop Drawings: For flexible ducts.

1. Include plans showing locations, mounting details, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved. Refer to Section 230500.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."

D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

A. Standard: Product is to be UL 181 listed and bearing the UL label.

B. Flexible Ducts, Insulated - Class 1, Black Polymer Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 4 inch wg positive and 0.5 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Polyethylene or Aluminized.

C. Flexible Ducts, Insulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Aluminized.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action. Nylon strap in sizes to suit duct size for low pressure polymer film flexible duct applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

A. Flexible ducts are not to be applied where the duct section will be visible to the occupants in finished spaces.

B. Install flexible ducts in accordance with applicable details in the following publications:

1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
2. NAIMA AH116.
3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

C. Connect terminal units to supply ducts directly, or with maximum 12-inch lengths of multiple layer flexible duct, clamped or strapped onto duct and terminal collar. Do not use flexible ducts to change directions.

D. Connect diffusers and light troffer boots to ducts directly, or with maximum 36 inch

lengths of polymer film flexible duct, clamped or strapped in place.

E. Connect flexible ducts to metal ducts with draw bands.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Install in accordance with ADC instructions.

G. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure blowers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and wind restraints.

C. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer for vibration control. Refer to specification Section 230548.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Refer to Section 230500.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 - PRODUCTS

2.1 BASIC REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Capacities and Characteristics:

1. Refer to schedules on plans
2. Motor:

2.2 RADIAL PRESSURE BLOWER EXHAUST FANS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Cincinnati Fan
2. Acme Engineering & Manufacturing Corp.
3. Central Blower Company

4. Lau Fan
5. New York Blower Company (The)
6. Donaldson (Torrit)

B. Radial blade pressure blower, cast aluminum with integral cast hub and blades.

1. Stamped steel housing of 14gauge minimum steel, round inlet and round discharged ready for direct connection to ductwork, without transition bidding. Baked powder coat finish on interior and outer surfaces of floor housing
2. Turned polished steel ground shafts with rust preventative coding, fan motor and bearing vibration levels under 1.5 mills displacement at design speed.
3. Heavy-duty, self-aligning grease lubricated ball bearings mounted in cast iron pillow blocks

C. Accessories:

1. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
2. Pitot airflow measurement traverse probe, multiple probe pitot totals total static and pressure sensing to provide measurement of airflow in a round duct to within +/- 3% of actual.
    a. Multiple ports equidistant distribution along length of each probe
    b. Separate probes cover entire round duct cross section, manifolded to deliver velocity pressure measurement that identifies flow rate in cfm.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

D. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Coordinate wall penetrations and flashing with wall construction.

F. Install units with clearances for service and maintenance.

G. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

D. Provide straight sections of inlet and exhaust ductwork required for proper operation of fan and accurate reading for probes in accordance with manufacturers' recommendations.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Division 26 specification sections for Low-Voltage Electrical Power Conductors and Cables.

B. Ground equipment according to Division 26 specification sections for Grounding and Bonding for Electrical Systems.

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 specification sections for Identification for Electrical Systems.
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 specification sections for Control-Voltage Electrical Power Cables.

3.5 STARTUP SERVICE:

A. Engage a factory-authorized service representative to assist in startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust speed through variable frequency drive control to cfm flow required by pressure readings at pitot probes, and conversion to cfm.

B. Lubricate bearings.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative, and using report forms and procedures from the various manufacturers.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Fans and components will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.9 DEMONSTRATION

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

END OF SECTION 233416

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal ventilators - roof downblast.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators.

C. Delegated Design Submittal: For unit wind bracing and supports required to comply with requirements and design criteria of the local authority having jurisdiction, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Refer to Section 230500.

B. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to ASCE/SEI 7

F. Capacities and Characteristics:

1. Refer to schedules on drawings

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Greenheck Fan Corporation
2. Acme Engineering & Manufacturing Corp.
3. Aerovent; a division of Twin City Fan Companies, Ltd.
4. American Coolair Corporation
5. Loren Cook Company
6. New York Blower Company (The)
7. Northern Blower, Inc.
8. PennBarry; division of Air System Components
9. S & P USA Ventilation Systems, LLC

B. Housing: Downblast; removable spun-aluminum dome top and outlet baffle, mushroom-domed top of spun aluminum; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades classified in accordance with AMCA 99, Section 8.

D. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops, auxiliary contacts.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.
2. Overall Height: 12 inches.
3. Metal Liner: Galvanized steel.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency

requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Electronically Commuted (EC) motor for fan speed control, integral transducer to generate DC power for fan motor and control from AC power input.

1. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
2. Internal motor circuitry shall convert AC power supplied to the fan to DC power to for motor control and operation.
3. Motor shall be capable of speed control down to 20% of full speed.
4. Speed shall be controlled by 0-10 VDC signal.
5. Motor shall be a minimum of 85% efficient at all speeds.
6. Motor is off when under 2 VDC.
7. Motor shall be a minimum of 85% efficient at all speeds.
8. Internal thermal and current protected, soft-start motor feature and gradual ramp-down.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. Refer to Division 7 specification sections for Roof Accessories, for installation of roof curbs.
2. Provide wind hold down cables, fasteners, securing fan to curb, curb to roof, to

confirm to requirements of the local Authority Having Jurisdiction.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Provide with interface or gateway, or resident control signal, compatible with, and read-write ready, for communication with project BAS. Refer to 230923 for digital controls and 230993 for sequences of operation.

C. Connect control wiring according to Division 26 specification sections for Control-Voltage Electrical Power Cables.

3.5 STARTUP SERVICE:

A. Perform startup service following manufacturer’s recommended procedure, utilizing manufacturer forms and start-up reports.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modulating, single-duct air terminal units.
2. Series fan-powered air terminal units.
3. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated Design Submittal: For vibration isolation and supports, and seismic restraints, where required; indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Design Calculations: Calculate requirements for selecting vibration isolators, supports, and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades. Refer to Section 230500.

B. Seismic Qualification Data: For air terminal units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 specification sections for Operation and Maintenance Data, include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1,

"Section 6 - Heating, Ventilating, and Air Conditioning."

D. Delegated Design: Engage a qualified professional engineer to design vibration isolation, supports, and seismic restraints, where required; including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Seismic Performance: Air terminal units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified
2. Component Importance Factor: 1.0.

2.2 TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Titus
2. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
3. ENVIRO-TEC
4. Krueger-HVAC
5. METALAIRE, Inc
6. Price Industries Limited
7. Tuttle & Bailey

2.3 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: Minimum 22-gauge thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for Casing Liner, Fibrous Glass" with "Antimicrobial Erosion-Resistant Coating" Subparagraph.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-

inch wg inlet static pressure.

D. Velocity Sensors: Multipoint array with velocity inlet sensors.

E. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide absorptive attenuator integral with the air terminal unit, with noise transmission loss performance as required in schedules on Drawings.

F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

G. Controls:

1. Electronic Damper Actuator: 24 V, fail in last position.
2. Electronic Thermostat: Wall-mounted electronic type with no display; refer to specification Section 230923.27
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet. Refer to specification Sections 230923 and 230923.12.

H. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.
    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, integrated actuators, and room sensors to be furnished under Section 230923 "Direct Digital Controls (DDC) for HVAC" and 230923.12 “Control Dampers”.
3. Control Sequence: See Section 230993 "Sequence of Operation for HVAC" and drawings.

2.4 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Description: Volume-damper assembly and centrifugal fan in series arrangement inside unit casing with control components inside a protective metal shroud.

1. Designed for quiet operation.

2. Low-profile design.

B. Casing: Minimum 20-gauge- thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for non fibrous, natural cotton-based interior lining insulation, 1” thick for thermal resistance and acoustical dampening.
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal.

C. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

D. Velocity Sensors: Multipoint array with velocity sensors in air inlet.

E. Fan Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Type: Electronically commutated motor, brushless DC.
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure: Totally enclosed, fan cooled.
5. Motor Bearings: permanently lubricated.
6. Efficiency: Premium efficient as defined by NEMA MG-1.
7. Service Factor: 1.15
8. Motor Speed: Variable speed.
    a. Speed Control: Infinitely adjustable with electronic controls.
9. Electrical Characteristics:
    a. 208 Volts
    b. Phase: 3
    c. Hertz: 60.

F. Filters:

1. Flat Glass Fiber: Factory-fabricated, self-supported disposable air filter with holding frames. Provide MERV 6 filters with minimum efficiency reporting value is to be in accordance with ASHRAE 52.

G. Attenuator Section, Inlet: Casing material and thickness matching associated air

terminal unit casing. Provide absorptive attenuator integral with the plenum inlet, filter replacement accessible without removal of inlet attenuator.

H. Attenuator Section, Outlet: Casing material and thickness matching associated air terminal unit casing, S-slip and drive for downstream duct connection. Provide absorptive attenuator integral with the air terminal unit, with noise transmission loss performance as required in schedules on Drawings.

I. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch. Include manual air vent and drain valve. Locate coil in discharge outlet airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

K. Electronic Controls:

1. Electronic Damper Actuator: 24 V, fail in last position.
2. Electronic Thermostat: Wall-mounted electronic type with no display
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet. Refer to specification Sections 230923 and 230923.12.

L. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.
    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Section 230923 "Instrumentation and Control for HVAC" and Section 230923.12 “Control Dampers”
2. Room Sensor: Wall mounted with no display; and access port for connection of portable operator terminal. Refer to Section 230923,27 “Temperature Instruments”
3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal unit manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) for HVAC", and Section 230923.12 “Controls Dampers”.

M. Control Sequence: See Section 230993.11 "Sequence of Operation for HVAC" and Drawings for control sequences.

2.5 CASING LINER

1. Antimicrobial, Erosion-Resistant.
2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916. Adhesive shall have a VOC content of 80 g/L or less.

2.6 SOURCE QUALITY CONTROL

A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880

B. AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.

C. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

D. Carefully coordinate locations of units to be positioned between existing floor and roof structural elements (beams and trusses), installing as high as possible, yet allowing service clearances for regular maintenance and installation of primary inlet ductwork and downstream outlet ductwork, and attenuators.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply piping with isolation valve, strainer, and union or flange; and to return piping with pressure-independent control valve, union or flange, and isolation valve.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories", and Section 233346 “Flexible ducts”

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Division 26 specification sections for Low-Voltage Electrical Power Conductors and Cables.

C. Ground equipment in accordance with Division 26 specification sections for Grounding and Bonding for Electrical Systems.

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 specification sections for Identification for Electrical Systems.
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 specification sections for Control-Voltage Electrical Power Cables.

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Linear bar diffusers.
4. Linear slot diffusers.
5. Round diffusres.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished, performance data including air flow rates, core velocities, air pressure drop, NC, throws.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.
6. Refer to section 230500.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of

the following available manufacturers offering products that may be incorporated into the Work:

1. Titus
2. Anemostat Air Distribution
3. Hart & Cooley, LLC
4. Krueger-HVAC
5. METALAIRE, Inc
6. Nailor Industries Inc
7. Price Industries Limited
8. Tuttle & Bailey

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, color selected by Architect.

E. Face Size: Refer to schedules

F. Face Style: Three cone.

G. Mounting: Provide as required for duct or surface to be mounted to, refer to architectural plans.

H. Pattern: Adjustable in 4 directions.

I. Dampers: Radial opposed blade.

2.2 LINEAR SLOT DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Titus
2. Anemostat Air Distribution
3. Hart & Cooley, LLC
4. Krueger-HVAC
5. METALAIRE, Inc
6. Nailor Industries Inc
7. Price Industries Limited
8. Tuttle & Bailey

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish - Tees: color selected by Architect.

E. Slot Width: 3/4 inch.

F. Number of Slots: two, three and four.

G. Length: 48 inches.

H. Accessories: Factory internally insulated galvanized steel plenum with duct connection collar, insulation to be non-microbial supporting material, and erosion resistant, meeting ASTM C1071 and ASTM C1338.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 SCHEDULES

A. 4-Way Square Supply Diffusers

CFM range	Face Size	neck size	Max NC	Core velocity Max	Max APD
400 - 470	24x24	12	22	600	.09
230 - 290	24x24	10	18	600	.07
165 - 225	24x24	8	18	700	.07
85 - 170	24x24	6	15	800	.09
30 - 60	12x12	4	15	600	.05

Referenced Product: Titus TMSA-AA

B. Round Concentric Supply Diffusers

CFM range	Face Diam	duct size	Max NC	Core velocity Max	Max APD
200 - 230	18	8	25	700	.08

Referenced Product: Titus TMRA-AA

C. Linear Slot Diffusers

CFM range	Length	# of Slots	Max NC	Vert throw	Max APD
300 - 330	48	4	25	20ft	.06
200 - 260	48	3	25	18ft	.07
100 - 150	48	2	18	14ft	.04

Referenced Product: Titus MP38 SP

3.4 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adjustable blade face registers and grilles.
2. Fixed face registers and grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished, performance including cfm flow rates, core velocities, NC, air pressure drop, throw.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.
6. Refer to section 230500

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Adjustable Blade Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be

incorporated into the Work:

a. Titus
b. Anemostat Air Distribution
c. Hart & Cooley, LLC
d. Krueger-HVAC
e. METALAIRE, Inc
f. Price Industries Limited
g. Tuttle & Bailey

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal, Vertical, spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Frame: 1 to 1-1/4 inches wide.
7. Mounting: Provide as required for ceilings and surfaces; refer to architectural plans.
8. Dampers: Adjustable opposed blade, 4 – way adjustment

2.2 GRILLES

A. Fixed Face Grille:

1. Manufacturers: subject to compliance with requirements provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

a. Titus
b. Anemostat Air Distribution
c. Hart & Cooley, LLC
d. Krueger-HVAC
e. METALAIRE, Inc
f. Price Industries Limited
g. Tuttle & Bailey

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Frame: 1 inch or 1-1/4 inches wide.
7. Mounting: Provide as required for ceilings and surfaces, refer to architectural plans.

B. Fixed Blade Return Grilles

1. Manufacturers: Subject to compliance with requirements provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

a. Titus

b. Anemostat Air Distribution
c. Hart & Cooley, LLC
d. Krueger-HVAC
e. METALAIRE, Inc
f. Price Industries Limited
g. Tuttle & Bailey

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Fixed 45 degree angle, ¾" spaced.
5. Frame: 1 inch or 1-1/4 inches wide.
6. Mounting: Non-ducted for ceilings; provide as required for ceilings, refer to architectural plans.
7. 24x12 face for up to 350 cfm, 24 x 24 face for up to 750 cfm; maximum core velocities of 300 fpm, maximum air pressure drop of .02" WC.
8. Referenced product: Titus 3FS

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 SCHEDULES

A. Wall and Ceiling Mounted Supply Registers

CFM range	Face Size	duct size	Max NC	Core velocity Max	Max APD
230 - 250	12x6	9	18	600	.06
170 - 230	10x6	8	18	700	.08
120 - 170	8x6	7	15	600	.06
20 - 100	6x6	6	15	600	.06

Referenced Product: Titus 272FL

B. Duct-Mounted supply grilles, with air factory air scoop damper.

CFM range	Face Size	Neck Size	Max NC	Core velocity Max	Max APD
100 - 175	16x4		15	500	.07
250 - 305	16x6	-	20	700	.11

Referenced Product: Titus S300FL-ASD

C. Fixed Blade Return Grilles

CFM range	Face Size	Neck Size	Max NC	Core velocity Max	Max APD
3400	48x24	-	19	500	.06

Referenced Product: Titus 350 FL

D. Ceiling mounted Exhaust Grilles

CFM range	Face Size	Neck Size	Max NC	Core velocity Max	Max APD
50 - 75	6x6	6	19	400	.05

Referenced Product: Titus 3FS

3.4 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed by Construction Manager, before starting air balancing.

END OF SECTION 233713.23

SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components, including the following:

1. Casings.
2. Fans, drives, and motors.
3. Coils.
4. Air filtration.
5. Dampers.
6. Sound attenuators.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.

1. Include plans, elevations, sections, and [mounting] [attachment] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For vibration isolation, supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[, supports, and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Owner acceptance of completion.

PART 2 - PRODUCTS PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 specifications for Quality Requirements, to design vibration isolation[and seismic restraints], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg.

2.2 INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Daikin
2. Carrier
3. Engineered Air
4. Trane

B. Unit Casings:

1. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
2. Base Rail:
    a. Material: Galvanized steel.
    b. Height: 6 inches.
3. Casing Joints: Hermetically sealed at each corner and around entire perimeter.
4. Double-Wall Construction:

a. Outside Casing Wall:

1) Material, Galvanized Steel: Minimum 18 gauge thick.
2) Factory Finish: Provide manufacturer's standard finish.

b. Inside Casing Wall:

1) Material, Galvanized Steel: Solid minimum 18 gauge thick.
2) Antimicrobial Coating: Applied during the manufacturing process. EPA approved, NSF approved.

5. Floor Plate:

a. Material, Galvanized Steel: 16 gauge thick.
b. Antimicrobial Coating: Applied during the manufacturing process. EPA approved, NSF approved.

6. Casing Insulation:

a. Materials: Injected polyurethane foam insulation
b. Casing Panel R-Value: Minimum R-13.
c. Insulation Thickness: 2 inches.
d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

7. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
8. Static-Pressure Classifications:

a. For Unit Sections Upstream of Fans: Minus 4-inch wg.
b. For Unit Sections Downstream and Including Fans: 4-inch wg

9. Panels, Doors, and Windows:

a. Panels:

1) Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

b. Doors:

1) Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.

4) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

c. Locations and Applications:

1) Fan Section.
2) Coil Section.
3) Access Section.
4) Damper Section:
5) Filter Section:.
6) Mixing Section:
7) Controls:.

10. Condensate Drain Pans:

a. Construction:

1) Single-wall, stainless-steel] sheet.
2) with foam insulation and moisture-tight seal.

b. Drain Connection:

1) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
2) Minimum Connection Size: NPS 1.

c. Slope: Minimum 0.125-in./ft slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
d. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
e. Width: Entire width of water producing device.
f. Depth: A minimum of 2 inches deep.

C. Fan, Drive, and Motor Section:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.
b. Turned, ground, and polished hot-rolled steel with keyway.
c. Shaft Bearings:

1) Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 bearing life rating, life of 200,000 hours according to ABMA 9.
2) Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing.

d. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

e. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

f. Mounting: For internal vibration isolation[and seismic control]. Factory-mount fans with manufacturer's standard[restrained] vibration isolation mounting devices having a minimum static deflection of 1 inch.

g. Flexible Connector: Factory fabricated to limit transmission of vibration to housing].

3. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt

4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

c. Enclosure Type: Open, dripproof or TEFC fan cooled.

d. Motor Bearings: grounded for use with VFD to limit impact of potentials, inverter duty.

e. Efficiency: Premium Efficient motors as defined in NEMA MG 1.

f. Motor Pulleys: Adjustable pitch for use with 5 hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

g. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

h. Mount unit-mounted disconnect switches on exterior of unit.

5. Comply with Section 262923 "Variable-Frequency Motor Controllers."

6. Variable-Frequency Motor Controller: Serving each fan individually.

a. Manufactured Units: Pulse-width modulated; constant torque, and variable torque for inverter-duty motors.

b. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range, 66 Hz. maximum voltage equals input voltage.

c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: 0.1 to 999.9 seconds.

d) Deceleration:0.1 to 999.9 seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency motor controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) Proportional Integral Directive (PID) control interface.
8) DDC system for HVAC Protocols for Network Communications: ASHRAE 135, fully communicating with the BAS, refer to section 230293.

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

D. Coil Section:

1. General Requirements for Coil Section:

a. Comply with AHRI 410.
b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
d. Coils shall not act as structural component of unit.

2. Preheat Coils:

a. Hot-Water Coils: Continuous circuit, Cleanable.

1) Piping Connections: Threaded, or flanged, same end of coil.
2) Tube Material: Copper.

3) Fin Type: Plate.
4) Fin Material: Copper.
5) Fin Spacing: Maximum 12 fins per inch.
6) Fin and Tube Joint: Silver brazed.
7) Headers:
   a) Cast iron with cleaning plugs and drain and air vent tappings extended to exterior of unit.
   b) Seamless copper tube with brazed joints, prime coated.
   c) Fabricated steel, with brazed joints, prime coated.
   d) Provide insulated cover to conceal exposed outside casings of headers.
8) Frames: Channel frame, 0.052-inch- thick, galvanized steel.
9) Coil Working-Pressure Ratings: 200 psig, 325 deg F.

3. Cooling Coils:
   a. Chilled-Water Coil: Continuous circuit, Cleanable.
      1) Piping Connections: Threaded or Flanged, same end of coil.
      2) Tube Material: Copper.
      3) Fin Type: Plate.
      4) Fin Material: Copper.
      5) Fin Spacing: 0.125 inch.
      6) Fin and Tube Joint: Mechanical bond or Silver brazed.
      7) Headers:
         a) Cast iron with[cleaning plugs and] drain and air vent tappings extended to exterior of unit.
         b) Seamless copper tube with brazed joints, prime coated.
         c) Fabricated steel, with brazed joints, prime coated.
         d) Provide insulated cover to conceal exposed outside casings of headers.
      8) Frames: Channel frame, 0.052-inch- thick, galvanized steel.
      9) Working-Pressure Ratings: 200 psig, 325 deg F.

E. Air Filtration Section:
   1. Particulate air filtration
   2. High-efficiency particulate air (MERV 13) filtration"
   3. Panel Filters:
      a. Description: Pleated, self-supported, disposable air filters with holding frames.
      b. Filter Unit Class: UL 900.
      c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.
      d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
   4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and

with a VOC content of 80 g/L or less.

5. Side-Access Filter Mounting Frames:
    a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel.
        1) Prefilters: Incorporate an integral 2-inch- thick track with same access as primary filter.
        2) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

F. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel or aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with -plated]steel operating rods rotating in stainless steel sleeve, sintered bronze or nylon bearings mounted in a single galvanized-steel or extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg, leakage Class 1] tested, rated, and labeled in accordance with AMCA 511.
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:
    a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
    b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
    c. Operator Motors:
        1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
        2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
        3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
    d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
    e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
    f. Size dampers for running torque calculated as follows:

1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
5) Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
6) Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

g. Coupling: V-bolt and V-shaped, toothed cradle.
h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): Refer to section 230923 for direct digital controls.
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
m. Temperature Rating: Minus 22 to plus 122 deg F].

5. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
6. Combination Filter and Mixing Section:

a. Cabinet support members shall hold 2-inch thick, pleated, flat, permanent or throwaway filters.
b. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.3 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B 09.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [3000] <Insert time>-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross hatch adhesion of 5B.

2. Application: [Immersion] [Spray].
3. Thickness: [1 mil] <Insert value>.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.

C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

D. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

G. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

H. Witnessed Casing Leakage Tests:

1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Install air-handling units on concrete equipment room floor. Coordinate sizes and locations with actual equipment provided.
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange, strainer, at each coil supply connection. Install pressure-independent control valve and union or flange at each coil return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 specifications for "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and

switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including

connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to assist in training for Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.16

SECTION 237343.16 - OUTDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes outdoor, semi-custom air-handling units that are factory assembled using multiple section components; including:

1. Unit casings.
2. Fan, drive, and motor section.
3. Coil section.
4. Air filtration section.
5. Dampers.
6. Roof curbs.
7. Intake and relief air openings.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each outdoor, semi-custom air-handling unit.

1. Include plans, elevations, sections, and mounting, attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of outdoor, semi-custom air-handling units, as well as procedure and diagrams.
4. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittal: For unit supports to indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and high wind restraints, brackets, fasteners, and for their design
2. Detail mounting, securing and fastening, and flashing unit curb to roof structure, indicate coordination required with roofing contractor for roof membrane system
3. Restraint details: Wind-detail, fabrication and attachment of wind restraints, brackets, steel and clips, fasteners, Show anchorage details and indicating quantities, sizes, depth of anchors and fasteners/anchors..

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Refer to section 230500.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Wind Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer. Submit certification that the specified equipment will withstand high wind forces identified in the performance requirements article and per section 230548.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control reports.

F. Startup service reports.

G. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: 2 years from the date of substantial completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: certification by a qualified professional engineer, as defined in division one specification sections for Quality Requirements, or a factory roof curb, associated clips, anchors and fasteners for high wind restraining of the unit and the curb.

1. Design air handling unit supports to comply with local wind and seismic performance requirements required by the authority having jurisdiction.

F. Structural Performance:

1. Casing Panels: Self-supporting and capable of withstanding positive/negative 8-inch wg internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.
2. Floor and Roof Panels: Self-supporting and capable of withstanding 300-lb static load at midspan, without exceeding a midpoint deflection of 0.0042 inch/inch
3. Roof Panels: Self-supporting and capable of withstanding a static snow load of 30 lb/sq. ft., without exceeding a midpoint deflection of 0.0042 inch/inch.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8-inch wg.

H. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified
2. Component Importance Factor: 1.0
3.

I. Wind Performance: Air-handling units are to withstand the effects of wind determined in accordance with ASCE/SEI 7, as required by the local authority having jurisdiction

2.2 UNIT CASINGS

A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.

B. Base Rail:

1. Material: Galvanized steel
2. Height: 6 inches.

C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.

D. Double-Wall Construction:

1. Outside Casing Wall:
   a. Material, Galvanized Steel: Minimum 18 gauge thick.
   b. Factory Finish: Provide manufacturer's standard finish.
2. Inside Casing Wall:
   a. Material, Galvanized Steel: Solid, minimum 18 gauge thick.
   b. Antimicrobial Coating: Applied during the manufacturing process. EPA approved, NSF approved.

E. Floor Plate:

1. Material:
    a. Galvanized steel, minimum 18 gauge thick.
2. Antimicrobial Coating: Applied during the manufacturing process. EPA approved, NSF approved.

F. Roof: Cross-broken and pitched with "C" caps over joints to provide watertight seal.

G. Piping Vestibule: Insulated with same insulation and thickness as casing, 18 inches deep by full width of unit to completely enclose piping, valves, specialties. Building piping connections shall be made from within curb, up into vestibule, without any piping or valves or piping specialties exposed to the outdoors..

H. Casing Insulation:

1. Materials: injected polyurethane foam insulation.
2. Casing Panel R-Value: Minimum R-13.
3. Insulation Thickness: [2 inches.
4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

I. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

J. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 4 inch wg.
2. For Unit Sections Downstream and Including Fans: 4-inch wg.

K. Panels, Doors, and Windows:

1. Panels:
    a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
    b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 18 inches [wide by full height of unit casing up to a maximum height of 60 inches.
2. Doors:
    a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
    b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside.

Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.

c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

3. Locations and Applications:

a. Fan Section:.
b. Coil Section:.
c. Access Section:
d. Damper Section:
e. Filter Section:.
f. Piping vestibules
g. Mixing Section.
h. Controls.

4. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.

L. Condensate Drain Pans:

1. Location: Each type of [cooling coil] [heat wheel].
2. Construction:

a. Single-wall, stainless-steel sheet, with foam insulation and moisture-tight seal.

3. Drain Connection:

a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
b. Minimum Connection Size: NPS 1.

4. Slope: Minimum 0.125-in./ft to comply with ASHRAE 62.1 in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.
    a. Turned, ground, and polished hot-rolled steel with keyway.
2. Shaft Bearings:
    a. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 rated life of 200,000 hours according to ABMA 9.
    b. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing with grease lines extended to outside
    c. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing[with grease lines extended to outside unit] and an L-50 rated life of 200,000.
3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
    a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
4. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
5. Mounting: For internal vibration isolation[and seismic control]. Factory-mount fans with manufacturer's standard[restrained] vibration isolation mounting devices having a minimum static deflection of 1 inch.
6. Shaft Lubrication Lines: Extended to a location outside the casing.
7. Flexible Connector: Factory fabricated to limit transmission of vibration to unit, building, ductwork

C. Drive, Direct: Factory-mounted, direct drive.

D. Motors:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: Totally enclosed, fan cooled, ECM motors.
4. Efficiency: Premium efficient as defined in NEMA MG 1

5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
6. Mount unit-mounted disconnect switches protected from weather.

E. Comply with Section 262923 "Variable-Frequency Motor Controllers."

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.

B. Preheat Coils:

1. Hot-Water Coils; Continuous circuit , Cleanable.
    a. Piping Connections: Threaded or Flanged, integral to cabinetry.
    b. Tube Material: Copper.
    c. Fin Type: Plate.
    d. Fin Material: Copper.
    e. Fin Spacing: Maximum 12 fins per inch.
    f. Headers:
        1) Cast iron with cleaning plugs and drain and air vent tappings
        2) Seamless copper tube with brazed joints, prime coated.
        3) Fabricated steel, with brazed joints, prime coated.
    g. Frames: Channel frame, 0.052-inch- thick, galvanized galvanized steel 0.079-inch- thick, minimum.
    h. Coil Working-Pressure Ratings: 200 psig, 325 deg F.
    i. Coating: None.

C. Cooling Coils:

1. Chilled-Water Coil: Continuous circuit, Cleanable.
    a. Piping Connections: Threaded or flanged, integral to cabinetry.
    b. Tube Material: Copper.
    c. Fin Material: copper.
    d. Fin and Tube Joint: Mechanical bond.
    e. Headers:
        1) Cast iron with cleaning plugs and drain and air vent tappings internal to cabinetry
        2) Seamless copper tube with brazed joints, prime coated.

3) Fabricated steel, with brazed joints, prime coated.
4) Provide insulated cover, casings of headers to be fully within unit cabinetry.

f. Frames: Channel frame, 0.052-inch- thick, galvanized steel.
g. Working-Pressure Ratings: 200 psig, 325 deg F.

2.5 AIR FILTRATION SECTION

A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

B. High-efficiency particulate air (HEPA) filtration is specified in Section 234133 "High-Efficiency Particulate Air Filtration."

C. Panel Filters:

1. Description: Pleated, factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

D. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

E. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.
   a. Prefilters: Incorporate an integral 2-inch- thick track with same access as primary filter.
   b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.6 DAMPERS

A. Dampers: Comply with requirements in Section 230923.12 "Control Dampers."

B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed]-blade arrangement with zinc-replated steel operating rods rotating in stainless steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg, leakage Class 1, tested, rated,

and labeled in accordance with AMCA 511.

C. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."

D. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): Select signal voltage to in keeping with BAS system, refer to section 230923.
11. Power Requirements (Modulating): Select signal voltage to in keeping with BAS system, refer to section 230923.
12. Proportional Signal: Select signal voltage to in keeping with BAS system, refer to section 230923..
13. Temperature Rating: Minus 22 to plus 122 deg F.

14. Run Time: [12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds].

E. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

2.7 ROOF CURBS

A. Provide curb, clips and fasteners as a system specifically suited for the unit to be installed, certified by qualified professional engineer, to attach unit and curb to roof structure for withstanding high wind conditions as required by the local authority having jurisdiction.

B. Roof curbs with wind restraints as required by local authority having jurisdiction, refer to section 230548 "Vibration and Seismic Controls for HVAC."

C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C1071, Type I or II.
   b. Thickness: 1 inch.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

D. Curb Dimensions: Height of 12 inches.

2.8 INTAKE AND RELIEF AIR OPENINGS

A. Provide hood, including moisture eliminator, over all unit intake and relief openings. Match material and finish of casing exterior.

2.9 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

2.10 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.

C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

D. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

G. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION, GENERAL

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install airhandlers on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7 specification. Secure airhandlers to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided..

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct following manufacturer’s recommendations

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow space for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange, strainer, at each coil supply connection. Install pressure independent control valve, and union or flange, at each coil return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Air-handling unit and components will be considered defective if unit or components do not pass tests and inspections.
5. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to assist in training Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237343.16

SECTION 237416.11 – PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components:

1. Unit casings.
2. Fans, drives, and motors.
3. Rotary heat exchanger.
4. Coils.
5. Refrigerant circuit components.
6. Air filtration.
7. Gas furnaces.
8. Dampers.
9. Electrical power connections.
10. Controls.
11. Roof curbs.
12. Accessories.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.3 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.

7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product Data: For air filtration performance.
3. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.

1. Include plans, elevations, sections, and mounting, attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and high wind restraints, and for their design.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: Wind-detail fabrication and attachment of wind restraints, brackets, steel and clips. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Refer to Section 230500.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control reports.

F. System startup reports.

G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of packaged, small-capacity, rooftop air-conditioning unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion
3. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. UL Compliance: Comply with UL 1995.

G. Delegated Design: Certification by a qualified professional engineer, as defined in Division 1 specification sections for Quality Requirements, for factory roof curb, clips and fasteners for high wind restraining of unit and curb.

1. Design RTU supports to comply with local wind and seismic performance requirements required by the Authority Having Jurisdiction.

2.2 PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Daikin
2. Carrier
3. Engineered Air
4. Trane

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
2. Inside Casing Wall: G90-coated galvanized steel.
3. Floor Plate: G90 galvanized steel minimum 18 gauge thick.
4. Casing Insulation:
    a. Materials: Injected polyurethane foam insulation.
    b. Casing Panel R-Value: Minimum.
    c. Insulation Thickness: 1 inch.
    d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream to comply with requirements in ASHRAE 62.1.

D. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 4-inch wg.
2. For Unit Sections Downstream and Including Fans: 4-inch wg.

E. Panels and Doors:

1. Panels:
    a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement to allow panels to be opened against air-pressure differential.
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
2. Access Doors:
    a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Locations:
    a. Fan Section.
    b. Access Section
    c. Coil Section.
    d. Damper Section.
    e. Filter Section.
    f. Furnace/Burner
    g. Mixing Section
    h. Relief-Return fans
    i. Controls

F. Condensate Drain Pans:

1. Location: Each type of cooling coil.
2. Construction:
    a. Single-wall, stainless steel sheet.
3. Drain Connection:
    a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    b. Minimum Connection Size: NPS 3/4.
4. Slope: Minimum to comply with ASHRAE 62.1, to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends).

5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
9. Units with stacked coils must have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower. Capable of modulation down to 30% of design flow with no surge.

B. Supply-Air Fans: Centrifugal, airfoil, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.
    a. Turned, ground, and polished hot-rolled steel with keyway.
2. Shaft Bearings:
    a. Heavy-duty, self-aligning, pillow-block type with an L-50 bearing life rating of minimum 100,000 hours according to ABMA 9.
3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
    a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
5. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
6. Flexible Connector: Factory fabricated to limit transmittal of vibration to ductwork, building.

C. Drives, Direct: Factory-mounted, direct drive.

D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.

E. Relief-Air Fan: SWSI air foil, shaft mounted on permanently lubricated motor.

F. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: Totally enclosed, fan cooled ECM motors.
4. Efficiency: Premium efficient as defined in NEMA MG 1.
5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils to not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper, interlaced.
2. Fins: Aluminum
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections
5. Frames: Galvanized steel.
6. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
    a. Working Pressure: Minimum 300 psig.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Compressors: Two Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

B. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9.

2.7 AIR FILTRATION

A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

B. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

C. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

D. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 GAS FURNACES

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

B. CSA Approval: Designed and certified by and bearing label of CSA.

C. Burners: Stainless steel.

1. Rated Minimum Turndown Ratio: 10 to 1.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
4. Gas Control Valve: Modulating.
5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

D. Heat-Exchanger and Drain Pan: Stainless steel.

E. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve with extension.

F. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards FM

Global.

2.9 DAMPERS

A. Comply with requirements in Section 230923.12 "Control Dampers."

B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate must not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg rated in accordance with AMCA 500D.

C. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."

D. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Refer to 230923 and 230993 specifications for required BacNet communication, signal types, operating sequences.
11. Temperature Rating: Minus 22 to plus 122 deg F.

2.10 ELECTRICAL POWER CONNECTIONS

A. RTU to have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.11 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and section 230993 for sequences of operation.

B. Basic Unit Controls:

1. Control-voltage transformer.
2. Annunciator Panel for Each Unit:
    a. Configuration: Unit-mounted.
    b. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
    c. DDC controller or programmable timer and interface with HVAC instrumentation and control system per section 230923.
    d. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

C. Controller:

1. Type: DDC, interfaced to BAS specified in section 230923.
2. Controller to have volatile-memory backup.
3. Safety Control Operation:
    a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
    b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire-alarm control panel.
    c. Fire-Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 specifications for "Addressable Fire-Alarm Systems."

d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply-air temperature is less than 40 deg F.

4. Scheduled Operation: Occupied and unoccupied periods on seven/365-day clock with a minimum of four programmable periods per day.
5. Refer to Section 230993 for sequences of operation for air handling units.
6. Supply Fan Operation:
   a. Occupied Periods: Run fan continuously.
   b. Unoccupied Periods: Cycle fan to maintain setback temperature.
7. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
   b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
8. Economizer Outdoor-Air Damper Operation:
   a. Occupied Periods: Open to required ventilation minimum intake, and up to maximum 100 percent of the fan capacity. Controller is to permit air-side economizer operation when outdoor air is less than 60 deg F. Use outdoor-air enthalpy and differential between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
   c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor to adjust for temperature, and output to range from 2- to 10-V dc, 4 to 20 mA.
9. Terminal-Unit Relays:
   a. Provide heating- and cooling-mode changeover relays compatible with terminal control system required in Section 233600 "Air Terminal Units" and Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet compatible interface for central HVAC control workstation for the following:
   a. Adjusting set points.
   b. Monitoring supply fan start, stop, and operation.
   c. Inquiring data to include outdoor-air damper position, supply- and room-air

temperature and humidity.
d. Monitoring occupied and unoccupied operations.
e. Monitoring constant and variable motor loads.
f. Monitoring variable-frequency drive operation.
g. Furnaces operation, percent full fire.
h. Monitoring cooling load.
i. Monitoring economizer cycles.
j. Monitoring air-distribution static pressure and ventilation air volume.

2.12 ROOF CURBS

A. Provide curb, clips and fasteners as a system specifically suited for the unit to be installed, certified by qualified professional engineer, to attach unit and curb to roof structure for withstanding high wind conditions as required by the local authority having jurisdiction.

B. Roof curbs with wind restraints as required by local authority having jurisdiction, refer to section 230548 "Vibration and Seismic Controls for HVAC."

C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C1071, Type I or II.
   b. Thickness: 1 inch.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

D. Curb Dimensions: Height of 12 inches.

2.13 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet is to be energized even if the unit main disconnect is open.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

C. Remote potentiometer to adjust minimum economizer damper position.

D. Safeties:

1. Smoke detector.
2. Condensate overflow switch.
3. Phase-loss reversal protection.
4. High and low pressure control.
5. Gas furnace airflow-proving switch.

E. Coil guards of painted, galvanized-steel wire.

F. Hail guards of galvanized steel, painted to match casing.

G. Outdoor-air intake weather hood with moisture eliminator.

2.14 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Spray.
3. Thickness: 1 mil
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.15 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7 specification. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate

general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to RTU, allow space for service and maintenance.

C. Connect piping to unit mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4 ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Gas Piping: Comply with applicable requirements in Section 221123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

3.4 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.5 ELECTRICAL CONNECTIONS

A. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs as specified in Division 26 specification sections for "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
3. Locate nameplate where easily visible.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 specifications for "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service technician to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, coils, and fans.
5. Inspect internal insulation.
6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean condenser coil and inspect for construction debris.
11. Clean furnace flue and inspect for construction debris.
12. Connect and purge gas line.
13. Remove packing from vibration isolators.
14. Inspect operation of relief dampers.
15. Verify lubrication on fan and motor bearings.
16. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
17. Adjust fan belts to proper alignment and tension.
18. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
19. Inspect and record performance of interlocks and protective devices; verify sequences.
20. Operate unit for an initial period as recommended or required by manufacturer.
21. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency:
    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum

firing rate and when burner is off. Calculate useful heat to supply air.

22. Calibrate thermostats.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
25. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.
28. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
29. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.
30. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied

conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. RTU will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

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

END OF SECTION 237416.11

SECTION 238126 – DUCTLESS SPLIT-SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.2 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.5 COORDINATION

A. Coordinate sizes and locations of equipment supports, and wall penetrations with actual equipment provided.

B. Refer to Section 230500 for Coordination drawings

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Two year(s) from date of Substantial Completion.
c. For Labor: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR-CONDITIONERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work:

1. Daikin
2. Mitsubishi Electric & Electronics USA, Inc.
3. Samsung HVAC
4. SANYO North America Corporation

2.2 INDOOR UNITS

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. ECM variable speed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.

d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:
   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 1 inch deep.
   b. Single-wall, galvanized steel sheet with foam insulation and moisture-tight seal.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      1) Minimum Connection Size: NPS 5/8.
   d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
7. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A. Washable media.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Heat Pump:
1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Variable-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant: R-410A.

d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Thermostat:

1. Low voltage with subbase to control compressor and evaporator fan.
2. Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

a. Compressor time delay.
b. 24-hour time control of system stop and start.
c. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
d. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Factory field settings and wind baffle to assure low-ambient operation to 5 F outdoors.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Condensate drainage pump: Factory provided float operated condensate removal pump, barbed outlet, minimum 10 ft WC lift capacity, integral alarms and contacts to shut off compressor and alert BAS in the event of failure to remove condensate.

G. Wall support bracket: Factory designed and fabricated of heavy galvanized steel for selected unit; powder-coated paint finish, pre-drilled with fasteners and hardware for securing bracket to wall, and heat pump to bracket.

H. Monitoring:

1. Monitor cooling and heating modes
2. All alarms
3. Space temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting bracket, plates, devices securely fastened to building structure.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit. Route to minimize the amount of the refrigerant piping exposed outdoors.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Provide condensate drainage piping with field applied insulation and vapor barrier to prevent condensation, discharge to mop basin in other room.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service Assistance: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to assist in startup service.

1. Complete installation and startup checks according to manufacturer's written instructions, using manufacturer report forms.
2. Operate and test all control functions, including condensate pump and alarms.

3.5 DEMONSTRATION

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

END OF SECTION 238126

SECTION 238239.13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and hot-water heating coils.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. DDC: Direct digital control.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using

input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Piping and electrical connection points.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
7. Perimeter moldings for exposed, partially exposed cabinets, partially recessed cabinets.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Modine
2. Airtherm
3. Beacon Morris
4. Daikin
5. Sterling
6. Trane
7. USA Coil & Air

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

application.

C. Assembly including casing, coil, fan, and motor in vertical or horizontal discharge configuration with adjustable discharge louvers.

D. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Cabinet unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified.

2.4 INSULATION

A. Insulation Materials:

1. Duct-Liner-Type, Glass-Fiber Insulation: ASTM C1071; front panel interior side, erosion-resistant coating to prevent erosion of glass fibers.
    a. Thickness: 1 inch.
    b. Thermal Conductivity (k-Value): 0.28 Btu x in./h x sq. ft. at 75 deg F mean temperature.
    c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.
    d. Adhesive: Comply with ASTM C916 and with NFPA 90A or NFPA 90B.
    e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 18 gauge thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 18 gauge thick sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Front panels fabricated of 16 gauge sheet steel.

5. Control Access Door: Key operated.
6. Base: 16 gauge thick steel, finished to match cabinet
7. Extended Piping Compartment to conceal hydronic specialties..
8. Cleanable expended aluminum filter protects fan. motor and coil.

B. UNIT HEATERS

1. Propeller type unit heaters for suspending from structure
2. Finish: Manufacturer's standard baked enamel applied to exterior cabinet
3. Factory assembled and tested before shipping.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
5. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.6 COILS

A. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater. Include manual air vent and drain.

2.7 FANS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, permanently split capacitor, multispeed; resiliently mounted on motor board. Refer to 230500 Common Motor Requirements
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.8 CONTROLS

A. Factory, Hot-Water Piping Package. Factory assembled to fit within cabinet yet accommodate service clearances.

1. ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
2. Two-way, modulating, pressure independent control valve, refer to Section 230923.11 “Control Valves”. Furnish control valve to unit manufacturer.
3. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
4. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
5. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A126, Class B); 125-psig

minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 threaded pipe and full-port ball valve in strainer drain connection.

6. Wrought-Copper Unions: ASME B16.22.

B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC", 230923.11 “Control Valves”, and Section 230993.11 "Sequence of Operations for HVAC DDC."

C. Interface with DDC System for HVAC Requirements:

1. Interface for scheduled operation from BAS.
2. Interface shall be BAC-net MSTP compatible for central DDC system for HVAC workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit-heater start, stop, and operating status.
   c. Data inquiry, including operating mode and room-air temperature reading.
   d. Occupied and unoccupied schedules.

D. Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 specification sections for Joint Sealants.

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend units from structure with elastomeric hangers

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Clean filters in each unit at turnover to Owner.

F. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Refer to Section 232113 "Hydronic Piping," and Section 232116 "Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL1995.

E. Unless otherwise indicated, install union and isolation valve on supply-water connection. Install union, isolation valve and control valve on return-water connection of cabinet unit heater.

F. Ground equipment according to Division 26 specification sections for "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 specification sections for "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project for this purpose.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 238239.13

SECTION 238239.19 - WALL AND CEILING HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall and ceiling heaters with electric-resistance heating.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:
   1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include details of anchorages and attachments to structure and to supported equipment.
   4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Wiring Diagrams: Power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL AND CEILING UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of

the following available manufacturers offering products that may be incorporated into the Work:

1. Berko; Marley Engineered Products
2. Chromalox, Inc.
3. INDEECO
4. Markel Products Company; a subsidiary of TPI Corporation
5. QMark; Marley Engineered Products

2.2 DESCRIPTION

A. Ceiling mounted electric resistance radiant eating panel; UL listed

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CONSTRUCTION

A. Panel assembly of minimum 22 ga formed galvanized sheet steel front, minimum 24 ga formed galvanized steel back, overlapping and riveted together at sides, Crystalline high temperature silicone surface finish on side facing space.

B. Powdered graphite encapsulated heating element with plastic lamination, heavy gage copper bus bars along entire element length, with 1 inch thick high density fiberglass backing, separated from the inside of the panel be dielectric insulation to assure uniform heat across radiated surface, and minimize loss of heat to ceiling. Maximum average temperature across surface of 165F.

2.4 ELECTRICAL

A. Factory pre-wired to heaters, power relay, and wall mounted thermostat having no display and hidden temperature adjustment.

B. Factory disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive ceiling heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Confirm voltage, wiring, configuration and protection of power available is appropriate and meets manufacturer's recommendations.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Division 26 specification sections for Grounding and Bonding for Electrical Systems.

E. Connect wiring according to Division 26 specification sections for Low-Voltage Electrical Power Conductors and Cables.

END OF SECTION 238239.19

COMPLETE RENOVATION/MECHANICAL UPGRADES FOR:

GREENE COUNTY PUBLIC LIBRARY

XENIA COMMUNITY LIBRARY

76 EAST MARKET ST.

XENIA, OH 45385

ABBREVIATION INDEX

&	AND	F.R.T.	FIRE RATED TREATED	P.V.C.	POLY VINYL CHLORIDE
@	AT	FT.	FOOT	Q.A.	QUARRY TILE
A/C	AIR CONDITIONING	FURN.	FURNITURE	QTY.	QUANTITY
A.D.	AREA DRAIN	GA.	GAUGE	R.A.	REGISTERED ARCHITECT
A.F.F.	ABOVE FINISH FLOOR	GALV.	GALVANIZED	RAD.	RADIUS
ALUM.	ALUMINUM	GYP. BD.	GYPSUM BOARD	REF.	REFRIGERATOR
ALT.	ALTERNATE	HDWD.	HARDWOOD	REINF.	REINFORCING
APPROX.	APPROXIMATE	HDR.	HEADER	REV.	REVISION
B/	BOTTOM OF	H.M.	HOLLOW METAL	REQ'D	REQUIRED
BD.	BOARD	HORIZ.	HORIZONTAL	RESIL.	RESILIENT
BLDG.	BUILDING	HGT.	HEIGHT	RM.	ROOM
BM.	BEAM	I.D.	INSIDE DIAMETER	R.O.	ROUGH OPENING
BSMT.	BASEMENT	INSUL.	INSULATION	SCHED.	SCHEDULE
BTWN.	BETWEEN	INT.	INTERIOR	SEC.	SECTION
BOT.	BOTTOM	JT.	JOINT	S.F.	SQUARE FOOT
C.L.	CENTER LINE	KIT.	KITCHEN	SHT.	SHEET
C.T.	CERAMIC TILE	LAM.	LAMINATE	SIM.	SIMILAR
CLG.	CEILING	LAV.	LAVATORY	SPEC.	SPECIFICATION
CLOS.	CLOSET	LT.	LIGHT	SQ.	SQUARE
CM	CONSTRUCTION MGR.	MAS.	MASONRY	S.S.	STAINLESS STEEL
CMU	CONC. MASONRY UNIT	MAX.	MAXIMUM	STD.	STANDARD
COL.	COLUMN	MECH.	MECHANICAL	STL.	STEEL
CONC.	CONCRETE	MTL.	METAL	STRUCT.	STRUCTURAL
CONT.	CONTINUOUS	MFR.	MANUFACTURER	SUSP.	SUSPENDED
CONST.	CONSTRUCTION	MIN.	MINIMUM	T/	TOP OF
DEPT.	DEPARTMENT	MISC.	MISCELLANEOUS	TEL.	TELEPHONE
DTL.	DETAIL	M.O.	MASONRY OPENING	THK.	THICK
D.F.	DRINKING FOUNTAIN	MTD.	MOUNTED	THRU	THROUGH
DIA.	DIAMETER	N.I.C.	NOT IN CONTRACT	T.O.P.	TOP OF PLATE
DIM.	DIMENSION	NO.	NUMBER	T.O.S.	TOP OF STEEL
DISP.	DISPENSER	NOM.	NOMINAL	T.O.SL.	TOP OF SLAB
DN.	DOWN	N.T.S.	NOT TO SCALE	TRT.	TREATED
DR.	DOOR	O.A.	OVERALL	TYP.	TYPICAL
D.S.	DOWN SPOUT	O.C.	ON CENTER	V.C.B.	VINYL COMPOSITION BASE
DWG.	DRAWING	O.D.	OUTSIDE DIAMETER	V.C.T.	VINYL COMPOSITION TILE
EA.	EACH	OPNG.	OPENING	VERT.	VERTICAL
EL.	ELEVATION	OPP.	OPPOSITE	V.I.F.	VERIFY IN FIELD
ELEC.	ELECTRICAL	OPT.	OPTIONAL	V.W.C.	VINYL WALL COVERING
EQ.	EQUAL	PL.	PLATE	W/	WITH
EQUIP.	EQUIPMENT	P.LAM.	PLASTIC LAMINATE	W.C.	WATER CLOSET
EXIST.	EXISTING	PLUMB.	PLUMBING	WD.	WOOD
EXT.	EXTERIOR	PLYWD.	PLYWOOD	W/O	WITHOUT
EWC	ELECTRIC WATER COOLER	PR.	PAIR	WP.	WATERPROOFING
F.D.	FLOOR DRAIN	PROP.	PROPERTY	WT.	WEIGHT
FIN.	FINISH	P.S.F.	PER SQUARE FOOT	WWM.	WELDED WIRE MESH
FL.	FLOOR	P.S.I.	PER SQUARE INCH		
F.O.	FACE OF	PTD.	PAINTED		

PROJECT TEAM

ARCHITECT:

K4 ARCHITECTURE + DESIGN

MEP ENGINEER:

Enhanse

STRUCTURAL ENGINEER:

Structural Consultants
ADVANTAGE GROUP ENGINEERS, INC.

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Ph: (513) 396-8900
FAX: (513) 396-8903
www.agengineers.com

CIVIL ENGINEER:

Abercrombie & Associates, Inc.
Civil Engineering + Surveying
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LANDSCAPE DESIGNER:

Yellow Springs Design
Roger Beal
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937-654-81999

GENERAL NOTES

1. THE USE OF THESE DOCUMENTS IS RESTRICTED TO THE ORIGINAL SITE FOR WHICH THEY WERE PREPARED. REUSE OR REPRODUCTION OF THE DOCUMENTS (WHOLE OR IN PART) FOR ANY OTHER PURPOSE IS PROHIBITED. K4 ARCHITECTURE, LLC. RETAINS ALL RIGHTS OF OWNERSHIP FOR THESE DOCUMENTS.
2. THE CONTRACTOR AND SUBCONTRACTORS SHALL BE SOLELY RESPONSIBLE FOR COMPLYING WITH ALL FEDERAL, STATE, AND LOCAL SAFETY REQUIREMENTS TOGETHER WITH EXERCISING PRECAUTIONS AT ALL TIMES FOR THE PROTECTION OF PERSONS INCLUDING EMPLOYEES AND PROPERTY. IT IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR AND SUBCONTRACTORS TO INITIATE, MAINTAIN, AND SUPERVISE ALL SAFETY REQUIREMENTS, PRECAUTIONS, AND PROGRAMS IN CONNECTION WITH THE WORK.
3. THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE TO COORDINATE ALL WORK AND FOR THE MEANS, METHODS, PROCEDURES, TECHNIQUES, AND SEQUENCE OF CONSTRUCTION.
4. THE GENERAL CONTRACTOR IS TO GUARANTEE ALL WORK INCLUDING WORK DONE BY SUBCONTRACTORS FOR A PERIOD OF ONE (1) YEAR COMMENCING WITH THE DATE OF SUBSTANTIAL COMPLETION.
5. GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR ALL SCHEDULING OF INSPECTIONS.
6. WHEN CONTRACTOR ACCEPTS DELIVERY OF ALL ITEMS NOTED ON PLANS EITHER IN CONTRACT OR NOT IN CONTRACT THEY SHALL BE RESPONSIBLE FOR LOSS AND/OR DAMAGE TO THESE ITEMS.
7. GENERAL CONTRACTOR TO HAVE JOB TRAILER AND PHONE ON PREMISES DURING ENTIRE CONSTRUCTION PERIOD.
8. THE GENERAL CONTRACTOR IS TO HAVE A FULL TIME QUALIFIED SUPERVISOR ON THE SITE AT ALL TIMES WHILE WORK IS BEING PERFORMED.
9. ALL DIMENSIONS SHOWN ARE NOMINAL DIMENSIONS UNLESS SPECIFICALLY NOTED OTHERWISE. THE GENERAL CONTRACTOR IS TO VERIFY ALL DIMENSIONS AND EXISTING FIELD CONDITIONS WITH THE DRAWINGS. IN PARTICULAR OVERALL WALL DIMENSIONS, SOIL CONDITIONS, INCOMING UTILITIES, ETC. GENERAL CONTRACTOR IS TO REPORT IMMEDIATELY TO THE ARCHITECT ANY VARIANCES OR FIELD CONDITIONS THAT MAY CAUSE CONSTRUCTION PROBLEMS PRIOR TO COMMENCING WORK.
10. DO NOT SCALE DRAWINGS. WRITTEN DIMENSIONS GOVERN. ALL PARTITION LOCATIONS, ALL DOOR AND OPENING LOCATIONS SHALL BE SHOWN ON FLOOR PLAN. IN CASE OF CONFLICT, NOTIFY THE ARCHITECT. FLOOR PLAN BY ARCHITECT SUPERCEDES ALL OTHER PLANS. ALL DIMENSIONS MARKED "CLEAR" OR "MIN." SHALL BE MAINTAINED AND SHALL ALLOW FOR THICKNESS OF ALL FINISHES INCLUDING CARPET, PAD, CERAMIC TILE, V.C.T., SLATWALL, ETC.
11. ALL DIMENSIONS SHOWN ARE TO FACE OF BLOCK OR FRAMING UNLESS SPECIFICALLY NOTED OTHERWISE.
12. PROVIDE PORTABLE FIRE EXTINGUISHERS WITH U.L. LABEL AND A RATING OF NOT LESS THAN 10lb-ABC WITH 75 FT TRAVEL DISTANCE TO ALL POSITIONS OF BUILDING OR AS DIRECTED BY THE FIRE DEPARTMENT FIELD INSPECTOR.
13. FIRE BLOCKING AT CONCEALED WALL SPACES. FIRE BLOCKING SHALL BE INSTALLED IN CONCEALED SPACES OF STUD WALLS AND PARTITIONS, INCLUDING FURRED OR STUDDED-OFF SPACES OF MASONRY OR CONCRETE WALLS, AND AT THE CEILING AND FLOOR OR ROOF LEVELS.
14. CONNECTIONS BETWEEN HORIZONTAL AND VERTICAL SPACES. FIRE BLOCKING SHALL BE INSTALLED AT ALL INTERCONNECTIONS BETWEEN VERTICAL AND HORIZONTAL SPACES SUCH AS OCCUR AT SOFFITS OVER CABINETS, DROP CEILINGS, COVE CEILINGS, AND SIMILAR LOCATIONS.
15. REQUIRED FLAME SPREAD RATING: INTERIOR FINISH OF WALLS AND CEILINGS SHALL HAVE A FLAME SPREAD RATING NOT GREATER THAN THAT DESIGNATED BY THE CLASS PRESCRIBED FOR THE VARIOUS GROUPS LISTED IN TABLE 803.4, WHEN TESTED IN ACCORDANCE WITH ASTM E-84.
16. ALL WOOD INSTALLED IN LOCATIONS IN CONTACT WITH MOISTURE TO BE PRESERVATIVE TREATED PER AWPA C1, C2, AND C9.
17. ALL GLASS UNITS LOCATED IN HAZARDOUS LOCATIONS SHALL COMPLY WITH TEST REQUIREMENTS OF CONSUMER PRODUCT SAFETY COMMISSION 16. CFR, PART 1201, FOR HUMAN IMPACT LOADS.
18. DOOR HARDWARE ON EGRESS DOORS SHALL ALLOW FOR EGRESS AT ALL TIMES WITHOUT THE USE OF A KEY OR SPECIAL KNOWLEDGE. ALL DOOR OPERATING DEVICES SHALL COMPLY WITH ADA AND BE OF LEVER DESIGN. SEE DOOR SCHEDULE FOR SPECIFIC DOOR HARDWARE FUNCTIONS.
19. ARCHITECT HIGHLY RECOMMENDS A PROFESSIONAL CAULKING CONTRACTOR THAT IS AUTHORIZED TO INSTALL ALL INTERIOR & EXTERIOR CAULKING / SEALANTS ON THIS PROJECT.
20. GENERAL CONTRACTOR & ALL SUBCONTRACTORS MUST REFER TO BOTH THE DRAWINGS & SPECIFICATIONS FOR THE COMPLETE SCOPE OF WORK. IT IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR & ALL SUBCONTRACTORS TO REVIEW THE COMPLETE SET OF DRAWINGS (SEE INDEX OF DRAWINGS, THIS SHEET) FOR SCOPE OF WORK AND QUANTITY OF MATERIAL.
21. INSTALLATION OF ALL MATERIAL SPECIFIED SHALL COMPLY WITH MANUFACTURE'S PRODUCT DATA, INCLUDING PRODUCT TECHNICAL BULLETINS, PRODUCT CATALOG INSTALLATION INSTRUCTIONS, PRODUCT CARTON INSTRUCTIONS, AND SPECIFICATIONS FOR HANDLING, STORAGE, INSTALLATION, AND CLEANING.
22. THE CONTRACTOR SHALL EVALUATE THE JOB SITE SAFETY THEREOF AND SHALL BE FULLY AND SOLELY RESPONSIBLE FOR THE JOB SITE SAFETY OF SUCH MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES.
23. CONTRACT DOCUMENTS ARE COMPLEMENTARY, AND WHAT IS REQUIRED BY ONE SHALL BE AS BINDING AS IF REQUIRED BY ALL.
24. BEFORE STARTING EACH PORTION OF THE WORK, THE CONTRACTOR SHALL CAREFULLY STUDY AND COMPARE THE VARIOUS DRAWINGS AND OTHER CONTRACT DOCUMENTS RELATIVE TO THAT PORTION OF THE WORK, SHALL TAKE FIELD MEASUREMENTS OF ANY EXISTING CONDITIONS RELATED TO THAT PORTION OF THE WORK AND SHALL OBSERVE ANY EXISTING CONDITIONS AT THE SITE AFFECTING IT. ANY ERRORS, INCONSISTENCIES OR OMISSIONS AND CONFLICTS DISCOVERED BY THE CONTRACTOR SHALL BE REPORTED PROMPTLY TO THE ARCHITECT AS A REQUEST FOR INFORMATION IN SUCH FORM AS THE ARCHITECT MAY REQUIRE FOR ARCHITECT'S RESOLUTION.
25. THE FURNISHINGS CONTRACT FOR THE ITEMS LISTED BELOW IS BY OTHERS. THE GENERAL CONTRACTOR SHALL NOT INCLUDE THESE MATERIALS OR INSTALLATION OF THESE ITEMS IN THEIR BID EXCEPT WHERE NOTED: FURNITURE, ARTWORK, GRAPHICS, INTERIOR DESIGN SERVICES
26. THE INTERIOR DESIGNER OR ARCHITECT WILL PROVIDE MATERIAL AND COLOR SELECTIONS FOR THE INTERIOR AND EXTERIOR FINISHES. THE MATERIAL AND INSTALLATION OF FINISHES IS BY THE GENERAL CONTRACTOR.
27. GENERAL CONTRACTOR IS RESPONSIBLE FOR CAULKING ALL CASEWORK AND BACKSPLASHES TO THE WALL.
28. THE DEMOLITION DRAWINGS AND ANY DRAWINGS ASSOCIATED WITH THE EXISTING BUILDING ARE INTENDED TO SHOW EXISTING CONDITIONS. EXISTING ARCHITECTURAL INFORMATION SHOWN WAS OBTAINED FROM EXISTING DRAWINGS BY K4 ARCHITECTURE, L.L.C (DATED 1976, 1990, 2000) AND CASUAL SITE VISITS. IN THE EVENT OF DISCREPANCY BETWEEN DRAWINGS AND ACTUAL, NOTIFY ARCHITECT IMMEDIATELY. DO NOT PROCEED WITH DEMOLITION OR CONSTRUCTION IN AREAS OF DISCREPANCY UNTIL ALL SUCH DISCREPANCIES HAVE BEEN RESOLVED.

GRAPHIC SYMBOLS

SECTION: 1 / A201 — SECTION NUMBER / SHEET NUMBER

DRAWING NOTES: 1

DOOR: 101 — DOOR NUMBER

WINDOW: A — WINDOW MARK

DETAIL: 1 / A403 — DETAIL NUMBER / SHEET NUMBER

PARTITION TYPES: A

ROOM: ROOM NAME 101 — ROOM NUMBER

COLUMN REFERENCE GRIDS: A

INTERIOR ELEVATION INDICATOR: 2 3 4 / A601 OR 1 / A201

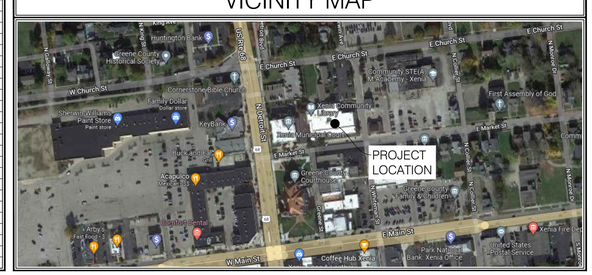
INDEX OF DRAWINGS

SHEET	DESCRIPTION	BID ISSUE - 01/04/23	ADDENDUM B - 01/20/23
T001	TITLE SHEET	●	●
PHASING DRAWINGS			
PH001	PHASING LIFE SAFETY PLAN	●	●
PH002	PHASING DEMO FLOOR PLAN & RCP	●	●
PH003	PHASING FLOOR PLAN & RCP	●	●
LIFE SAFETY DRAWINGS			
LS101	FIRST FLOOR LIFE SAFETY PLAN AND CODE INFORMATION	●	●
LS102	SECOND FLOOR LIFE SAFETY PLAN AND CODE INFORMATION	●	●
CIVIL DRAWINGS			
C100	DETAILS/NOTES	●	
C200	EX. CONDITIONS/DEMOLITION PLAN	●	
C300	GRADING PLAN	●	
C400	LAYOUT PLAN	●	
STRUCTURAL DRAWINGS			
S001	GENERAL STRUCTURAL NOTES	●	
S002	GENERAL STRUCTURAL NOTES	●	
S110	FOUNDATION PLAN	●	●
S120	SECOND FLOOR FRAMING PLAN	●	●
S130	ROOF FRAMING PLAN	●	●
S310	FOUNDATION SECTIONS	●	●
S311	FOUNDATION SECTIONS		●
S320	FRAMING SECTIONS	●	●
S321	FRAMING SECTIONS	●	●
S322	FRAMING SECTIONS	●	●
S323	FRAMING SECTIONS		●
DEMOLITION DRAWINGS			
D101	FIRST FLOOR DEMOLITION PLAN	●	●
D102	SECOND FLOOR DEMOLITION PLAN	●	●
D201	FIRST FLOOR DEMOLITION RCP	●	
D202	SECOND FLOOR DEMOLITION RCP	●	
D401	DEMOLITION EXTERIOR ELEVATIONS	●	●
D402	DEMOLITION ENLARGED EXTERIOR ELEVATIONS	●	●
D501	DEMOLITION WALL SECTIONS		
D502	DEMOLITION WALL SECTIONS		
ARCHITECTURAL DRAWINGS			
L-001	SITE LANDSCAPE PLAN	●	
A001	ARCHITECTURAL SITE PLAN	●	●
A011	FIRST FLOOR ROUGH-IN PLAN	●	
A012	SECOND FLOOR ROUGH-IN PLAN	●	
A101	FIRST FLOOR PLAN	●	●
A102	SECOND FLOOR PLAN	●	●
A111	ROOF PLAN	●	●
A113	ROOF DETAILS	●	
A114	STANDING SEAM ROOF DETAILS	●	
A201	FIRST FLOOR REFLECTED CEILING PLAN	●	●
A202	SECOND FLOOR REFLECTED CEILING PLAN	●	●
A203	FIRST FLOOR CEILING SECTIONS & DETAILS	●	●
A204	FIRST FLOOR CEILING SECTIONS & DETAILS	●	●
A205	SECOND FLOOR CEILING SECTIONS & DETAILS	●	●
A210	ENLARGED CEILING PLAN DETAILS	●	
A211	ENLARGED CEILING PLAN DETAILS	●	
A212	ENLARGED CEILING PLAN DETAILS	●	
A213	ENLARGED CEILING PLAN DETAILS	●	
A214	ENLARGED CEILING PLAN DETAILS	●	
A301	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A302	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A303	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A304	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A305	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A306	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A307	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A308	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A309	FIRST FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	●
A311	SECOND FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A312	SECOND FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A313	SECOND FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A314	SECOND FLOOR ENLARGED PLANS, ELEVATIONS, & DETAILS	●	
A401	EXTERIOR ELEVATIONS	●	
A402	EXTERIOR ELEVATION DETAILS	●	
A501	BUILDING SECTIONS	●	
A502	BUILDING SECTIONS	●	
A503	WALL SECTIONS	●	
A504	WALL SECTIONS	●	
A505	WALL SECTIONS	●	
A506	WALL SECTIONS		●
A601	FIRST FLOOR PLAN DETAILS	●	●
A602	FIRST FLOOR PLAN DETAILS	●	●
A603	SECOND FLOOR PLAN DETAILS	●	●
A801	DOOR SCHEDULE AND DETAILS	●	
A802	FIRST FLOOR STOREFRONT ELEVATIONS	●	
A803	SECOND FLOOR STOREFRONT ELEVATIONS	●	
A804	DOOR DETAILS	●	

INDEX OF DRAWINGS

SHEET	DESCRIPTION	BID ISSUE - 01/04/23	ADDENDUM B - 01/20/23
FIRE PROTECTION DRAWINGS			
FP0.0	FIRE PROTECTION NOTES AND LEGENDS	●	
FP1.1	FIRST FLOOR FIRE PROTECTION MODIFICATIONS	●	
FP1.2	SECOND FLOOR FIRE PROTECTION MODIFICATIONS	●	
FP2.1	FIRE PROTECTION DETAILS AND DIAGRAMS	●	
PLUMBING DRAWINGS			
P0.0	PLUMBING NOTES AND LEGENDS	●	
P1.1	FIRST FLOOR PLUMBING DEMO & NEW PLAN	●	
P1.2	SECOND FLOOR PLUMBING DEMO & NEW PLAN	●	
P1.3	ROOF PLUMBING DEMO & NEW PLAN	●	
P2.1	PLUMBING DETAILS AND DIAGRAMS	●	
P2.2	PLUMBING DETAILS AND DIAGRAMS	●	
P2.3	PLUMBING DETAILS AND DIAGRAMS	●	
MECHANICAL DRAWINGS			
M0.0	HVAC NOTES AND LEGENDS	●	
M0.1	FIRST FLOOR HVAC DEMOLITION PLAN	●	
M0.2	SECOND FLOOR HVAC DEMOLITION PLAN	●	
M0.3	ROOF HVAC DEMOLITION PLAN	●	
M1.1	FIRST FLOOR HVAC NEW DUCTWORK	●	
M1.2	SECOND FLOOR HVAC NEW DUCTWORK	●	
M1.3	ROOF HVAC NEW PLAN	●	
M2.1	FIRST FLOOR HVAC NEW PIPING PLAN	●	
M2.2	SECOND FLOOR HVAC NEW PIPING PLAN	●	
M3.1	HVAC DETAILS AND DIAGRAMS	●	
M3.2	HVAC DETAILS AND DIAGRAMS	●	
M4.1	HVAC SCHEDULES	●	
M4.2	HVAC SCHEDULES	●	
M4.3	HVAC SCHEDULES	●	
M4.4	HVAC SCHEDULES	●	
M5.1	HVAC PIPING DIAGRAMS	●	
M6.0	HVAC CONTROLS PLANS	●	
M6.1	HVAC CONTROLS DIAGRAMS	●	
ELECTRICAL DRAWINGS			
E0.0	ELECTRICAL LEGEND AND ABBREVIATIONS	●	
EPH0.1	ELECTRICAL PHASING PLANS	●	
E.01	FIRST FLOOR ELECTRICAL DEMOLITION PLAN	●	
E.02	SECOND FLOOR ELECTRICAL DEMOLITION PLAN	●	
E1.1	FIRST FLOOR LIGHTING PLAN	●	
E1.2	SECOND FLOOR LIGHTING PLAN	●	
E2.1	FIRST FLOOR POWER PLAN	●	
E2.2	SECOND FLOOR POWER PLAN	●	
E2.3	ENLARGED POWER PLANS	●	
E2.4	ROOF POWER PLAN	●	
E3.1	FIRST FLOOR SYSTEMS PLAN	●	
E3.2	SECOND FLOOR SYSTEMS PLAN	●	
E4.1	ELECTRICAL DETAILS & SINGLE LINE DIAGRAM	●	
E4.2	PANELBOARD SCHEDULES	●	
E4.3	LIGHT FIXTURE SCHEDULE	●	
E5.1	ROUGH-IN DETAILS & LIGHTING ZONES	●	
E5.2	WIRING DIAGRAMS	●	
E5.3	WIRING DIAGRAMS	●	
INTERIOR DRAWINGS			
101	FIRST FLOOR FINISH PLAN	●	
102	SECOND FLOOR FINISH PLAN	●	
103	RESTROOM ELEVATIONS	●	
201	FIRST FLOOR CEILING FINISH PLAN		
202	SECOND FLOOR CEILING FINISH PLAN		
501	CASEWORK PLANS, SECTIONS, & DETAILS	●	
502	CASEWORK PLANS, SECTIONS, & DETAILS	●	
503	CASEWORK PLANS, SECTIONS, & DETAILS	●	

VICINITY MAP



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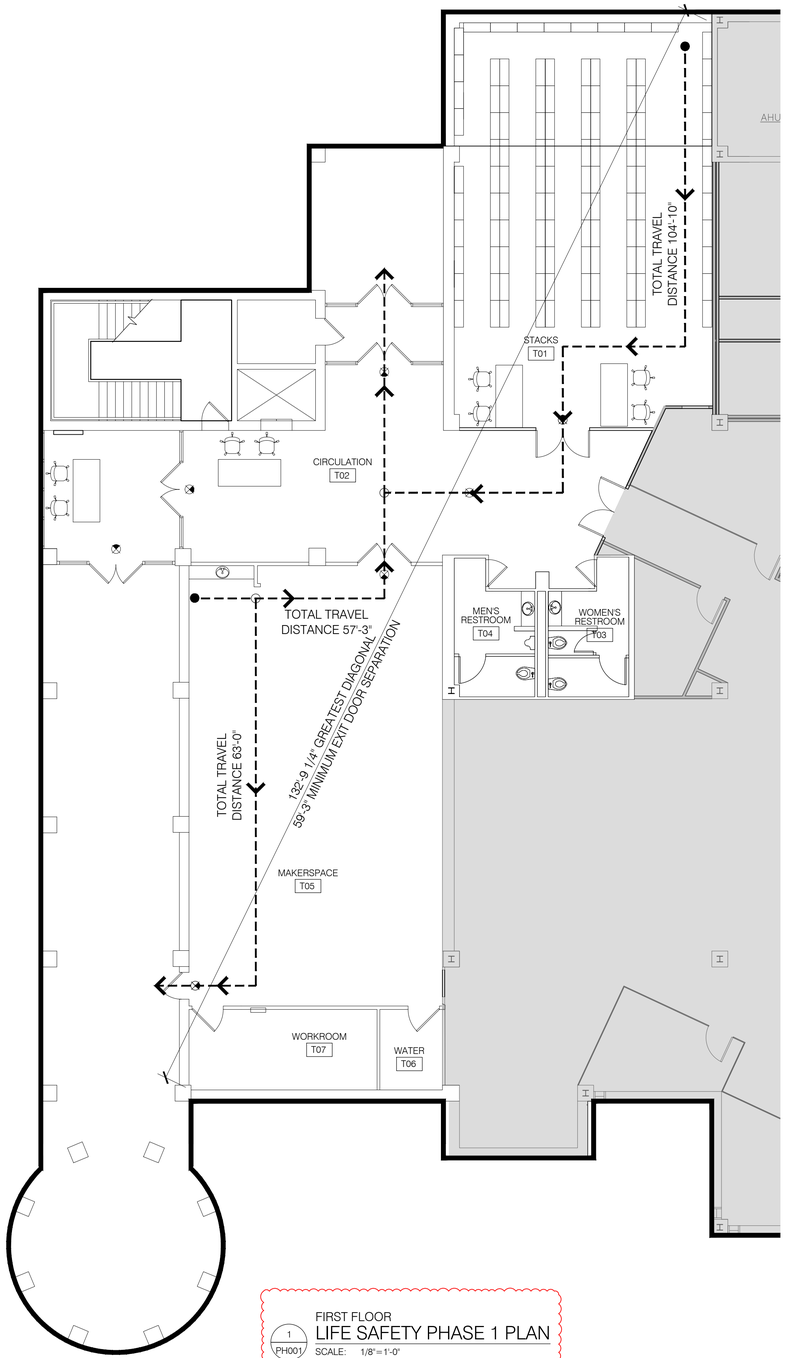
PRELIMINARY BID NOT FOR CONSTRUCTION

TITLE SHEET

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

T001



FIRST FLOOR
LIFE SAFETY PHASE 1 PLAN
1 / PH001 SCALE: 1/8"=1'-0"

B

SCOPE OF WORK:

PHASE 1
AREAS INDICATED AS PHASE I SHALL BE TURNED OVER TO CONTRACTOR AT COMMENCEMENT OF CONSTRUCTION. THESE AREAS, FOR A MAKER-SPACE RELOCATED FROM SECOND FLOOR BY CLIENT, AND SMALL STACK AREA RELOCATED BY CLIENT, SHALL BE PREPARED AS SHOWN TO PERMIT TEMPORARY OCCUPANCY FOR THE PUBLIC AND STAFF DURING THE DURATION OF THE REMAINDER OF THE WORK DESCRIBED IN THESE DOCUMENTS ON THE FIRST AND SECOND FLOORS. DURING THIS PHASE I CONSTRUCTION PERIOD THE CLIENT WILL BE RESPONSIBLE FOR REMOVING ALL CONTENTS AND EQUIPMENT (OTHER THAN THOSE ITEMS BEING RELOCATED INTO THE TEMPORARY OCCUPANCY SPACES) AND PREPARING TO TURN THAT SPACE (THE REMAINDER OF THE FIRST AND ALL OF THE SECOND FLOORS, OVER TO THE CONTRACTOR FOR THE REMAINDER OF THE CONTRACT PERIOD. AS SOON AS PARTIAL OCCUPANCY OF THE FIRST FLOOR PUBLIC AND STAFF AREAS CAN BE OBTAINED, THE PHASE I AREAS TEMPORARILY OCCUPIED DURING CONSTRUCTION SHALL BE TURNED OVER TO THE CONTRACTOR TO COMPLETE THE REMAINDER OF THE SCOPE IN THOSE AREAS.

ALL LIFE SAFETY SYSTEMS TO ALLOW TEMPORARY OCCUPANCY IN PHASE I DESIGNATED AREAS SHALL BE FUNCTIONALLY RETAINED AS REQUIRED TO INCLUDE, BUT NOT LIMITED TO: EGRESS DOORS AND PATHWAYS (SEE LIFE SAFETY PLAN FOR PHASE I AREAS), EGRESS AND EMERGENCY LIGHTING, SPRINKLER AND ALARM SYSTEMS, POWER, LIGHTING AND HVAC SYSTEMS AS DESCRIBED IN THESE DOCUMENTS. IT IS UNDERSTOOD THAT PERIODIC SHUTDOWNS OR CLOSURES IN THIS TEMPORARILY OCCUPIED AREA MAY BE NECESSARY TO ALLOW CONTINUATION OF PROGRESS IN THE OTHER AREAS OF THE BUILDING.

IT IS ANTICIPATED THAT THIS PHASE I AREA WORK SHALL BE COMPLETED IN 8 WEEKS FOLLOWING THE COMMENCEMENT OF WORK ON THE CONTRACT, AND THAT THE CLIENT WILL HAVE COMPLETELY VACATED THE REMINDER OF THE BUILDING DURING THIS TIME-FRAME.

B

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. GENERAL CONTRACTOR SHALL MAINTAIN ADEQUATE NUMBER OF EXITS AT ALL TIMES DURING CONSTRUCTION.
C. GENERAL CONTRACTOR TO MAINTAIN REQUIRED MEANS OF EGRESS AT ALL TIMES DURING CONSTRUCTION..

LEGEND:

- EXIT ACCESS TRAVEL DISTANCE
- COMMON PATH OF EGRESS TRAVEL
- EXIT SIGN ON BATTERY BACKUP
- WALL MOUNTED EMERGENCY EGRESS LIGHT (BATTERY PACK WITH 2 HEADS)
- MOST REMOTE POINT
- POINT OF DECISION

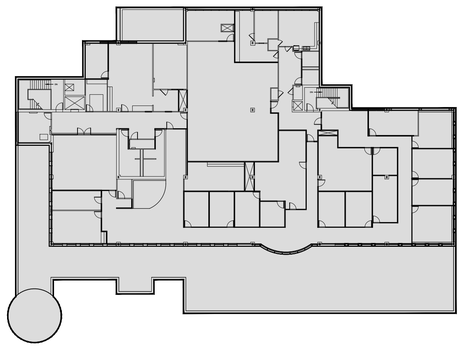
CODE INFORMATION

REFER TO LS101 FOR ADDITIONAL APPLICABLE CODE INFORMATION.

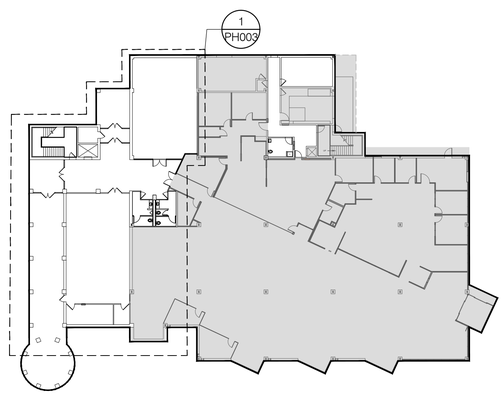
OCCUPANT LOAD PER ROOM:

T01 STACKS	1,287 sf	100sf/OCC	13 OCC
T02 CIRCULATION	1,062 sf	300sf/OCC	4 OCC
T03 RESTROOM	120 sf	100sf/OCC	0 OCC
T04 RESTROOM	118 sf	100sf/OCC	0 OCC
T05 MAKERSPACE	1,084 sf	50sf/OCC	22 OCC
T06 WATER	63 sf	300sf/OCC	0 OCC
T07 WORKROOM	133 sf	100sf/OCC	2 OCC
UNOCCUPIABLE SPACE	398 sf		0 OCC
FIRST FLOOR TOTAL	4,265sf		41 OCC

B



FIRST FLOOR
PHASE 1 PLAN
3 / PH001 SCALE: 1/32"=1'-0"



FIRST FLOOR
PHASE 1 PLAN
2 / PH001 SCALE: 1/32"=1'-0"

B

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PHASING
LIFE SAFETY PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

PH001

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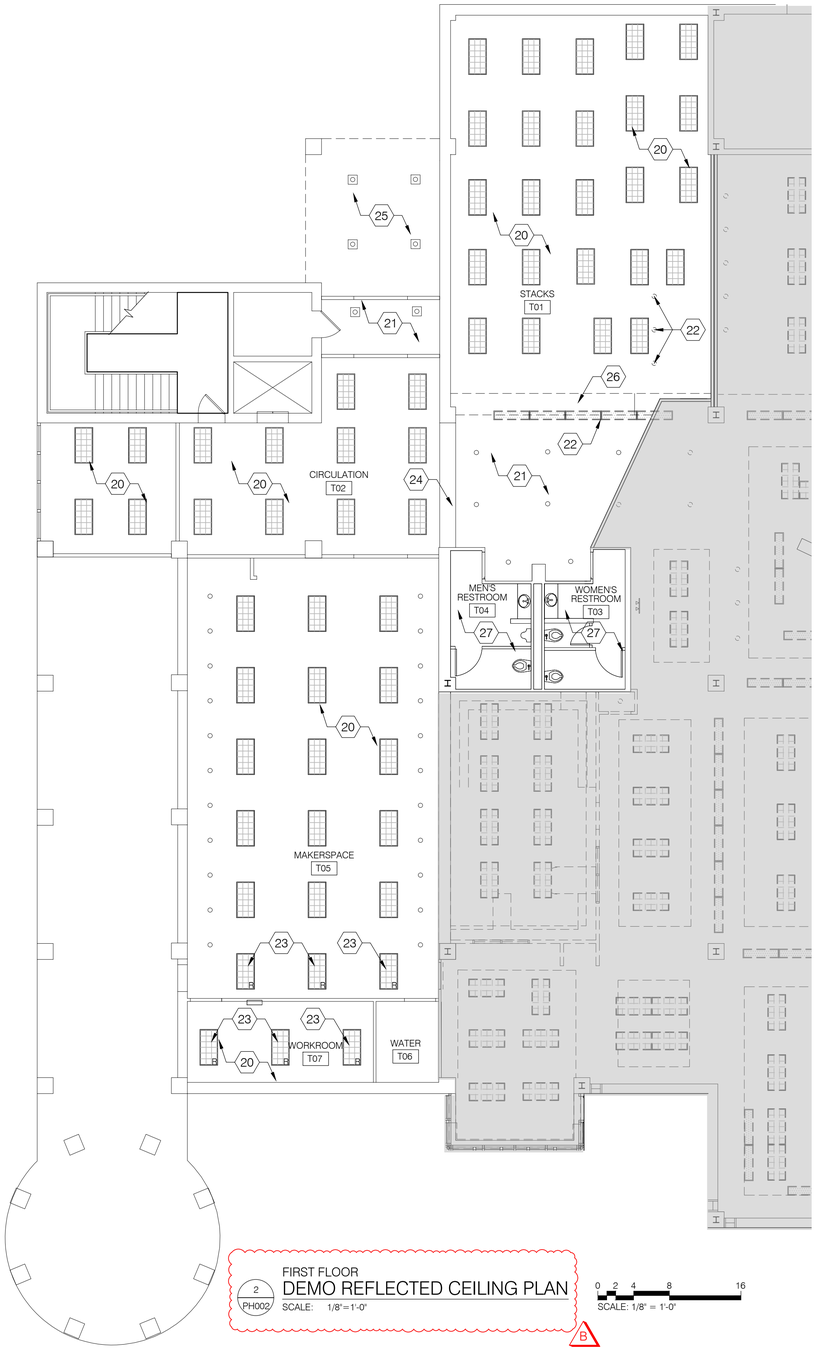
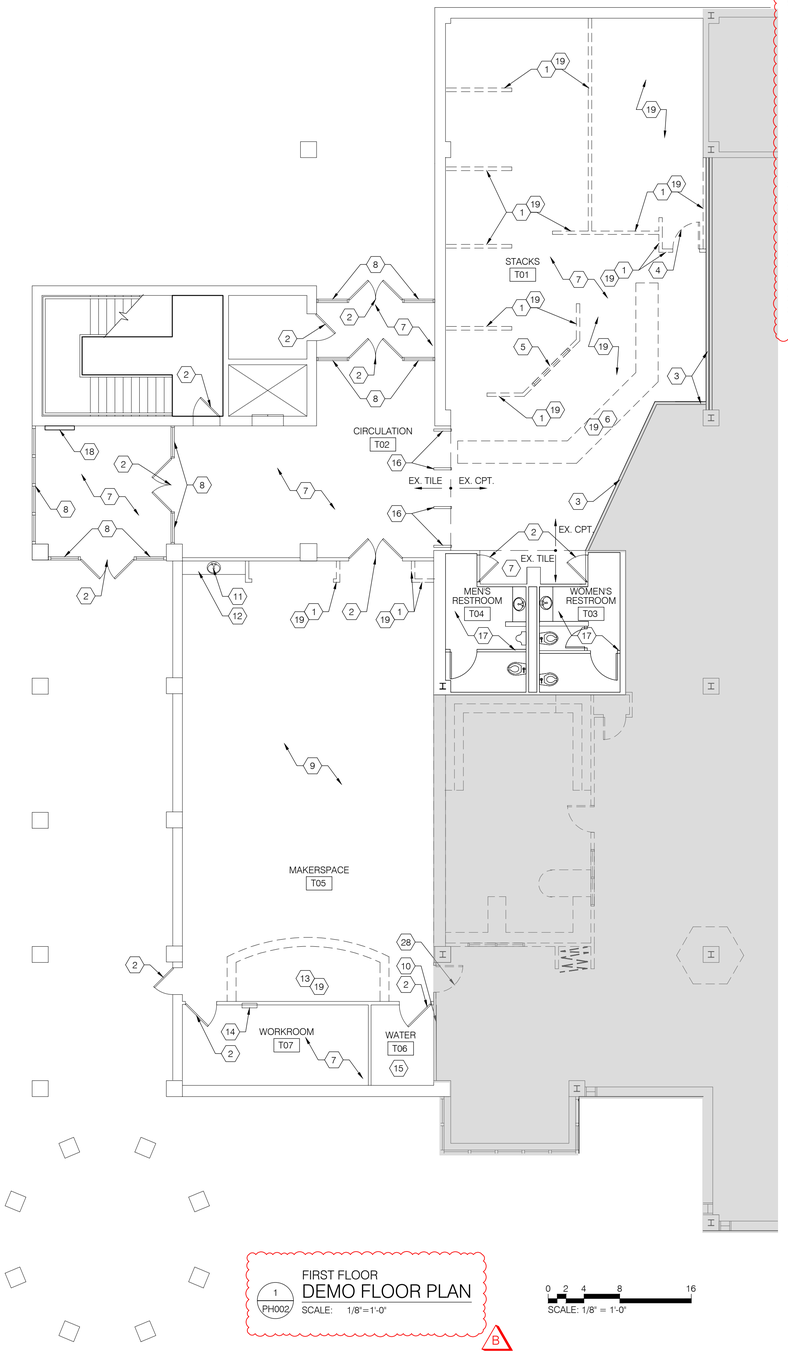


FIRST FLOOR
2 / PH002 DEMO REFLECTED CEILING PLAN
SCALE: 1/8"=1'-0"

SCALE: 1/8" = 1'-0"



FIRST FLOOR
1 / PH002 DEMO FLOOR PLAN
SCALE: 1/8"=1'-0"

SCALE: 1/8" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. FIELD LOCATE PORTABLE FIRE EXTINGUISHERS WITH FIRE MARSHAL PER INTERNATIONAL FIRE CODE - CABINETS SHALL BE SIMILAR TO JL INDUSTRIES, PANORAMA SERIES, 1037P42.
C. GENERAL CONTRACTOR TO MAINTAIN REQUIRED MEANS OF EGRESS AT ALL TIMES DURING CONSTRUCTION.
D. PATCH FLOORING AS NECESSARY.

NOTES THIS DRAWING:

1. REMOVE EXISTING WALL PARTITION.
2. EXISTING DOOR TO REMAIN.
3. TEMPORARY PARTITION WALL. REFER TO 1/PH003 FOR ADDITIONAL DETAILS.
4. REMOVE EXISTING DOOR, FRAME, AND ALL ASSOCIATED HARDWARE.
5. REMOVE EXISTING ALUMINUM STOREFRONT AND ALL ASSOCIATED HARDWARE.
6. REMOVE EXISTING CASEWORK/SHELVING.
7. EXISTING FLOOR TO REMAIN.
8. EXISTING GLAZING TO REMAIN. PROTECT THROUGHOUT CONSTRUCTION.
9. REMOVE CARPET PAD AND UNDERLAYMENT AS NEEDED FOR NEW FLOORING.
10. PORTION OF EXISTING WALL PARTITION TO REMAIN.
11. EXISTING PLUMBING FIXTURES TO REMAIN. REFER TO PLUMBING DRAWINGS FOR ADDITIONAL DETAILS.
12. EXISTING CASEWORK TO REMAIN.
13. REMOVE STAGE.
14. EXISTING ELECTRICAL PANEL TO REMAIN. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
15. EXISTING WATER SERVICE TO REMAIN. REFER TO PLUMBING DRAWINGS.
16. EXISTING RFID SECURITY GATE TO REMAIN. COORDINATE WITH OWNER FOR FINAL LOCATION..
17. EXISTING RESTROOM TO REMAIN.
18. EXISTING FIRE ALARM ANNUNCIATOR PANEL TO REMAIN. REFER TO FIRE PROTECTION AND ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
19. GENERAL CONTRACTOR TO INFORM ARCHITECT OF CONDITION OF FLOOR POST REMOVAL OF CASEWORK/WALLS. REPLACE FLOORING AS NEEDED.
20. EXISTING ACT CEILING, GRID, LIGHT FIXTURES, AND ASSOCIATED WIRING TO REMAIN. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
21. EXISTING GYPSUM BOARD CEILING, LIGHT FIXTURES, AND ASSOCIATED WIRING TO REMAIN. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
22. REMOVE EXISTING LIGHT FIXTURE.
23. RELOCATE/REUSE LIGHT FIXTURE FROM PHASE 1 WORK AREA.
24. EXISTING BULKHEAD TO REMAIN.
25. EXISTING BREEZEWAY CEILING, LIGHT FIXTURES, AND ASSOCIATED WIRING TO REMAIN. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
26. REMOVE BULKHEAD. INFILL AREA WITH ACT CEILING. TIE INTO EXISTING GRID.
27. NO CEILING WORK IN THIS AREA. EXISTING TO REMAIN.
28. REMOVE HARDWARE AND SEAL DOOR COMPLETELY TO PREVENT ACCESS BETWEEN SPACES.

B

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CONSTRUCTION

PHASING DEMO
FLOOR PLAN
& RCP

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

PH002

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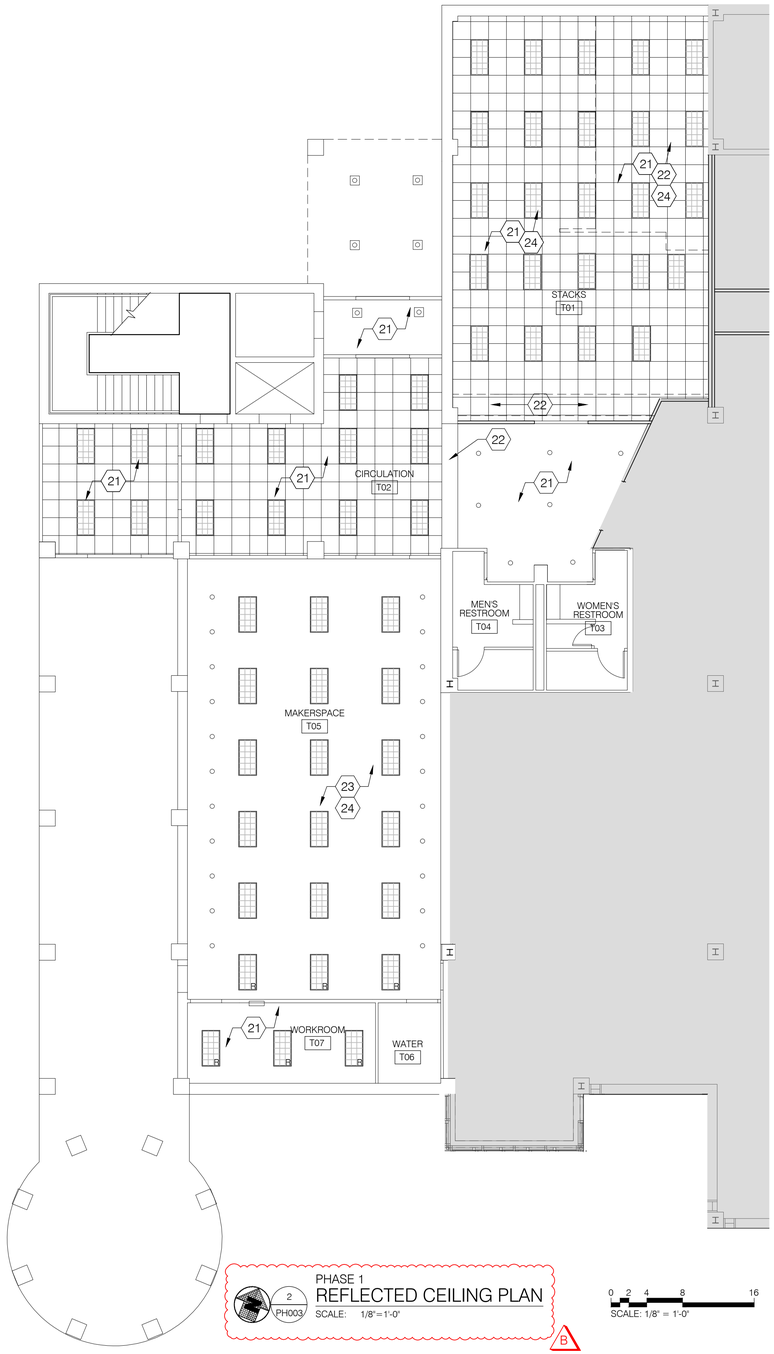
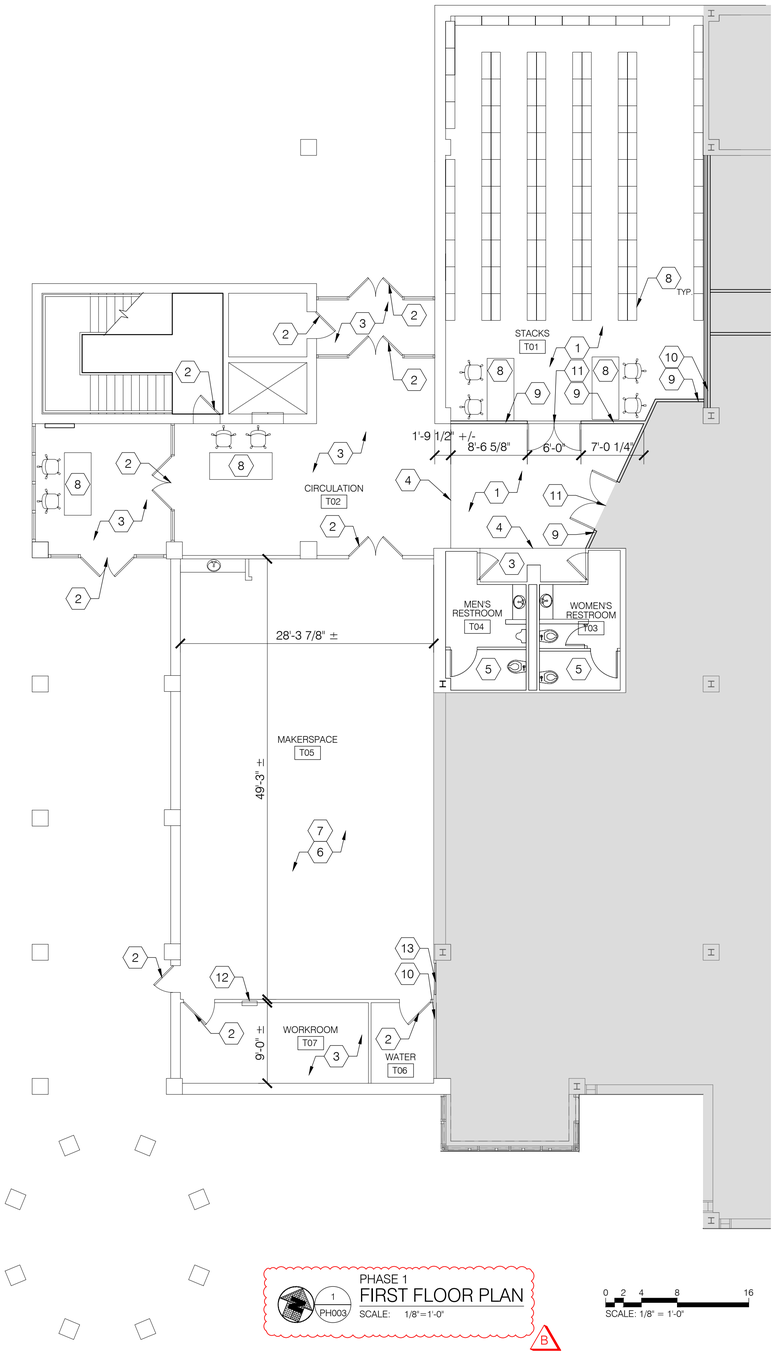


PHASE 1
REFLECTED CEILING PLAN
SCALE: 1/8"=1'-0"

0 2 4 8 16
SCALE: 1/8" = 1'-0"



PHASE 1
FIRST FLOOR PLAN
SCALE: 1/8"=1'-0"

0 2 4 8 16
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. FIELD LOCATE PORTABLE FIRE EXTINGUISHERS WITH FIRE MARSHAL PER INTERNATIONAL FIRE CODE - CABINETS SHALL BE SIMILAR TO JL INDUSTRIES, PANORAMA SERIES, 1037P42.
C. GENERAL CONTRACTOR TO MAINTAIN REQUIRED MEANS OF EGRESS AT ALL TIMES DURING CONSTRUCTION.
D. PATCH/REPAIR ALL DRYWALL AS A RESULT OF RECONFIGURATION OF EXISTING TO TEMPORARY SPACE.
E. GENERAL CONTRACTOR SHALL PAINT ALL NEW WALLS CREATED FOR TEMPORARY SPACE. COLOR TO BE DETERMINED BY ARCHITECT.

NOTES THIS DRAWING:

1. EXISTING CARPET TO REMAIN. PATCH AS NEEDED FOR TEMPORARY SPACE.
2. EXISTING DOOR TO REMAIN.
3. EXISTING TILE FLOOR TO REMAIN.
4. EXISTING FLOORING TRANSITION STRIP.
5. EXISTING RESTROOM TO REMAIN. TO BE USED BY LIBRARY STAFF / PATRONS ONLY.
6. MAKERSPACE EQUIPMENT, RELOCATED FROM SECOND FLOOR MAKERSPACE. PLACEMENT TO BE COORDINATED WITH LIBRARY STAFF AND ELECTRICAL ENGINEER. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
7. CONCRETE FLOOR TO BE MADE LEVEL FOR PATRON USE.
8. TEMPORARY FURNITURE, RELOCATED FROM EXISTING LIBRARY. PLACEMENT TO BE COORDINATED WITH LIBRARY STAFF.
9. NEW TEMPORARY WALL TO BE BUILT. 3-5/8" METAL STUDS @ 24" O.C. FILL WALL CAVITY WITH R-13 INSULATION. INSTALL 1/2" GYPSUM BOARD ON PATRON SIDE, PLYWOOD ON EXTERIOR. EXTEND ENTIRE STRUCTURE TO UNDERSIDE OF DECK.
10. PERMANENT WALL - ALUMINUM DOUBLE STUD 3-5/8" STUD WALL (24" O.C.) WITH 1" AIR GAP AND R-13 INSULATION. EACH FACE IS DOUBLE 1/2" GYPSUM BOARD WITH GREEN GLUE IN BETWEEN. STUDS TO BE STAGGERED BETWEEN TWO WALLS TO INCREASE SOUND ATTENUATION. EXTEND TO UNDERSIDE OF DECK. INSTALL 1/2" PLYWOOD WITH LAYER OF VISQUEEN ON CONSTRUCTION SIDE. PLYWOOD AND VISQUEEN TO BE REMOVED AT THE CONCLUSION OF PHASE 1, ONCE INTERIOR FINISHES ARE READY TO BE APPLIED. WALL TO RECEIVE NEW FINISHES.
11. NEW TEMPORARY DOOR. SALVAGE FROM PHASE 1 DEMO.
12. EXISTING ELECTRICAL PANEL TO REMAIN. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
13. REMOVE HARDWARE AND SEAL DOOR COMPLETELY TO PREVENT ACCESS BETWEEN SPACES

21. EXISTING CEILING/LIGHTS TO REMAIN. RECONFIGURE LIGHTS TO FIT WITHIN EXISTING GRID WHEN NECESSARY.
22. PAINT ACT CEILING AS A RESULT OF DEMOLITION
23. OPEN GRID CEILING.
24. EXISTING LIGHTS TO REMAIN.

B

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PHASING
FLOOR PLAN
& RCP

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

PH003

CODE INFORMATION:

21-2113 - GCPL XENIA BRANCH
COMPLETE RENOVATION/MECHANICAL UPGRADES

PROJECT LOCATION:
76 EAST MARKET STREET
XENIA, OH 45385

JURISDICTION: GREENE COUNTY DEPARTMENT OF BUILDING REGULATION
ZONING CODE: XENIA PLANNING AND ZONING DEPARTMENT
BUILDING CODE: OHIO BUILDING CODE, 2017 ED.

CHAPTER 3 - USE AND OCCUPANCY CLASSIFICATION
303.4 ASSEMBLY GROUP A-3
OCCUPANCY CLASSIFICATION IS ASSEMBLY GROUP A-3, LIBRARY

CHAPTER 5 - GENERAL BUILDING HEIGHTS AND AREAS
TB 504.3 ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE
(TYPE IIB CONSTRUCTION, GROUP A-3, SPRINKLERED)
ALLOWABLE HEIGHT: 75'-0"
ACTUAL HEIGHT: 28'-4" EXISTING

TB 504.4 ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE
(TYPE IIB CONSTRUCTION, GROUP A-3, SPRINKLERED)
ALLOWABLE HEIGHT: 3 STORIES
ACTUAL NUMBER OF STORIES: 2 STORIES EXISTING

TB 506.2 ALLOWABLE AREA FACTOR
(TYPE IIB CONSTRUCTION, GROUP A-3, SPRINKLERED (SM) = TWO OR MORE STORIES ABOVE GRADE PLANE)

ALLOWABLE AREA:	28,500 SF
ALLOWABLE AREA DUE TO FRONTAGE INCREASE:	61,180 SF*
FIRST FLOOR AREA:	20,465 SF
SECOND FLOOR AREA:	16,219 SF
TOTAL ACTUAL AREA (EXISTING):	36,684 SF
PROPOSED ADDITION FIRST FLOOR:	1,746 SF
PROPOSED ADDITION SECOND FLOOR:	EXISTING, NO CHANGE
TOTAL AREA (INCLUDES PROPOSED ADDITIONS):	38,430 SF

*TB 506.2.3 SINGLE-OCCUPANCY, MULTISTORY BUILDINGS ALLOWABLE AREA (DUE TO FRONTAGE INCREASE)
(EQUATION 5-2)
ALLOWABLE AREA = A_a = [A_t + (NS x I_f)] x S_s = [28,500 + (9,500 x .22)] x 2 = 61,180 SF

AREA FACTOR INCREASE (USED IN EQUATION 5-2) = I_f = [(F/P) - .25] x (W/30) = [(453/772) - .25] x (20/30) = .22

NO INDIVIDUAL STORY SHALL EXCEED ALLOWABLE AREA (A_a) AS DETERMINED BY EQUATION 5-2 USING THE VALUE OF S_s = 1 ~ 30,590 SF
// FIRST FLOOR AREA = 22,211 SF; SECOND FLOOR AREA = 16,219 SF

CHAPTER 6 - TYPES OF CONSTRUCTION
TB 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS
(TYPE IIB)
STRUCTURAL FRAME: 0HR
EXTERIOR BEARING WALLS: 0HR
INTERIOR BEARING WALLS: 0HR
EXTERIOR NONBEARING WALLS AND PARTITIONS: PER TABLE 602
INTERIOR NONBEARING WALL AND PARTITIONS: 0HR
FLOOR CONSTRUCTION: 0HR
ROOF CONSTRUCTION: 0HR

TB 602 FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS
(IIIB CONSTRUCTION, B OCCUPANCY GROUP)
LESS THAN 10FT: 1HR
10FT OR MORE: 0HR

CHAPTER 7 - FIRE-RESISTANCE-RATED CONSTRUCTION
THERE ARE NO CHANGES PROPOSED TO FIRE RATED ASSEMBLIES.
705 EXTERIOR WALLS
705.5 FIRE RESISTANCE RATINGS
PER TB 602

CHAPTER 9 - FIRE PROTECTION SYSTEMS
903.2.1.3 GROUP A-3 - BUILDING IS FULLY SPRINKLERED EXCEPT THE AREAS OF THE 'GREENE COUNTY ROOM' (ROOM 207) AND ROOM 205. THESE AREAS IN THEIR FORMER LOCATIONS WERE EXEMPTED FROM BEING FULLY SPRINKLERED VIA DECISION OF THE STATE OF OHIO BOARD OF BUILDING APPEALS CASE #90-229. PER THE PROVISIONS OF THE DECISION THE AFOREMENTIONED ROOMS SHALL BE PROTECTED BY A SUPERIOR SMOKE DETECTION/FIRE PROTECTION SYSTEM.

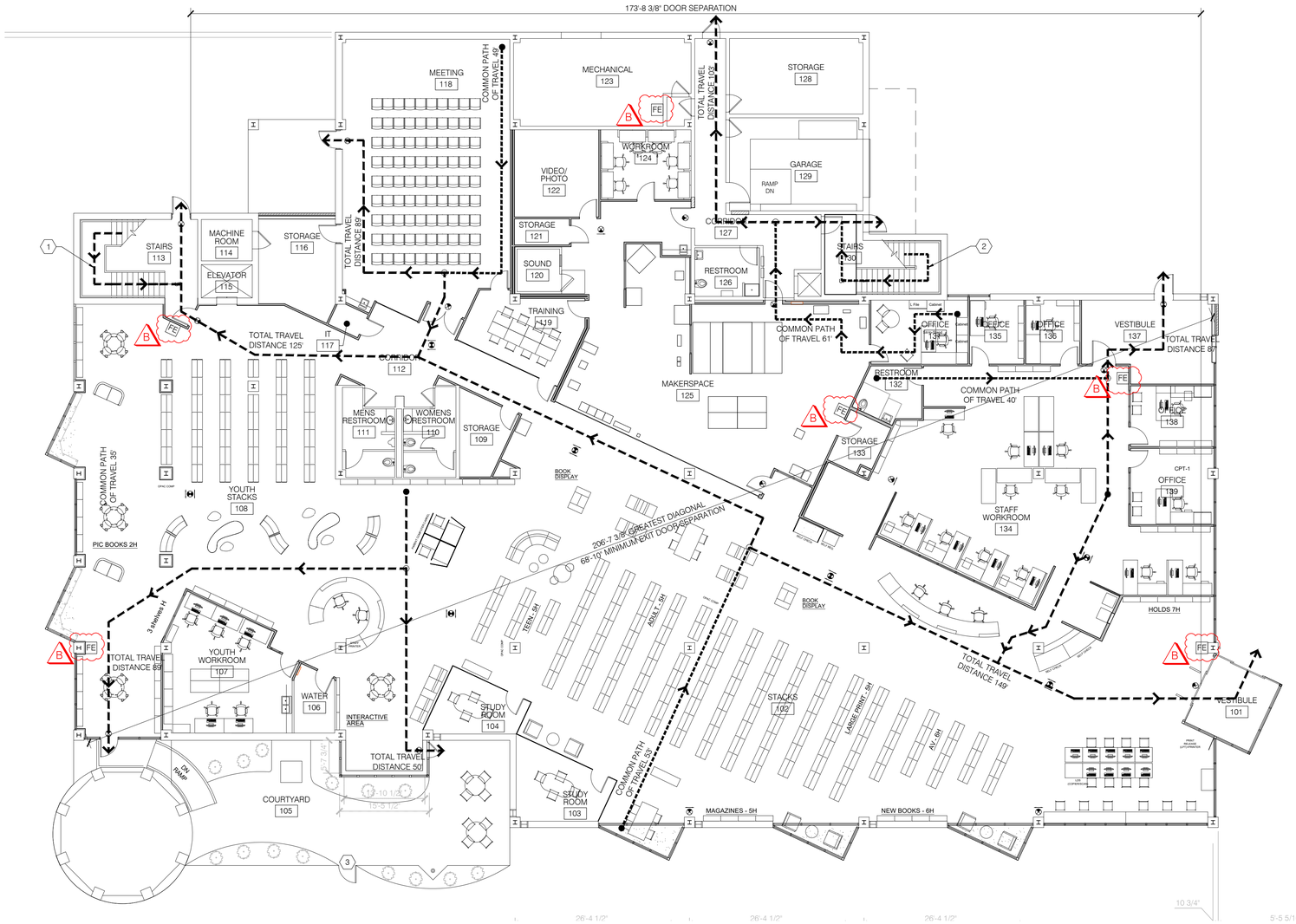
CHAPTER 10 - MEANS OF EGRESS
TB1004.1.2 MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT
(SEE OCCUPANT LOAD BREAKDOWN PER ROOM ON SHEET LS101 AND LS102)

FIRST FLOOR TOTAL:	408 OCCUPANTS
SECOND FLOOR TOTAL:	110 OCCUPANTS
GRAND TOTAL:	518 OCCUPANTS

TB1006.3.1 MINIMUM NUMBER OF EXITS OR ACCESS TO EXITS PER STORY
OCCUPANT LOAD PER STORY (1-500): (2) EXITS REQUIRED, (2) PROVIDED

CHAPTER 11 - ACCESSIBILITY
1101.2 DESIGN
BUILDINGS AND FACILITIES SHALL BE DESIGNED AND CONSTRUCTED TO BE ACCESSIBLE IN ACCORDANCE WITH THE CODE AND ICC A117.1 AS AMENDED IN SECTION 1112 OF THE CHAPTER.

CHAPTER 29 - PLUMBING SYSTEMS
TB 2902.1 MINIMUM NUMBER OF REQUIRED PLUMBING FACILITIES
(A-3 USE GROUP, 573 OCCUPANTS)
WATER CLOSET:
REQUIRED (MALE): 1 PER 125 = 2
REQUIRED (FEMALE): 1 PER 65 = 5
PROVIDED: (4) MALE, (4) FEMALE, (5) UNISEX
LAVATORY:
REQUIRED: 1 PER 200 = (2) MALE, (2) FEMALE
PROVIDED: (2) MALE, (2) FEMALE, (5) UNISEX
DRINKING FOUNTAIN:
REQUIRED: 1 PER 500 = 2
PROVIDED: (2), EXISTING
SERVICE SINK:
REQUIRED: (1)
PROVIDED: (1), EXISTING



1 LS101 — 1ST FLOOR LIFE SAFETY PLAN
SCALE: 1/8"=1'-0"

SCALE: 1/8" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. FIELD LOCATE PORTABLE FIRE EXTINGUISHERS WITH FIRE MARSHAL PER INTERNATIONAL FIRE CODE - CABINETS SHALL BE SURFACE MOUNTED U.N.O.

LEGEND:

- EXIT ACCESS TRAVEL DISTANCE
- COMMON PATH OF EGRESS TRAVEL
- EXIT SIGN ON BATTERY BACKUP
- WALL MOUNTED EMERGENCY EGRESS LIGHT (BATTERY PACK WITH 2 HEADS)
- MOST REMOTE POINT
- POINT OF DECISION
- FE — FIRE EXTINGUISHER

OCCUPANT LOAD PER ROOM:

101 VESTIBULE	150 sf	100sf/OCC	0 OCC
102 STACKS	6,232 sf	100sf/OCC	63 OCC
103 STUDY ROOM	178 sf	50sf/OCC	4 OCC
104 STUDY ROOM	138 sf	50sf/OCC	3 OCC
105 COURTYARD	1574 sf**	TO BE ASSIGNED BY BUILDING OFFICIAL PER SECTION 1004.5	
106 WATER	75 sf	300sf/OCC	0 OCC
107 YOUTH WORKROOM	436 sf	100sf/OCC	5 OCC
108 YOUTH STACKS	3,828 sf	100sf/OCC	39 OCC
109 STORAGE	108 sf	300sf/OCC	0 OCC
110 WOMEN'S RESTROOM	120 sf	100sf/OCC	0 OCC
111 MEN'S RESTROOM	118 sf	100sf/OCC	0 OCC
112 CORRIDOR	360 sf	300sf/OCC	0 OCC
113 STAIRS	295 sf	100sf/OCC	0 OCC
114 MACHINE ROOM	63 sf	300sf/OCC	0 OCC
115 ELEVATOR	51 sf	100sf/OCC	0 OCC
116 STORAGE	207 sf	300sf/OCC	0 OCC
117 IT	24 sf	300sf/OCC	0 OCC
118 MEETING	1,314 sf	7sf/OCC	188 OCC
119 TRAINING	234 sf	7sf/OCC	34 OCC
120 SOUND	54 sf	50sf/OCC	2 OCC
121 STORAGE	43 sf	300sf/OCC	0 OCC
122 VIDEO / PHOTO	218 sf	50sf/OCC	5 OCC
123 MECHANICAL	430 sf	300sf/OCC	0 OCC
124 WORKROOM	187 sf	100sf/OCC	2 OCC
125 MAKERSPACE	1,587 sf	50sf/OCC	32 OCC
126 RESTROOM	90 sf	100sf/OCC	0 OCC
127 CORRIDOR	345 sf	300sf/OCC	0 OCC
128 STORAGE	298 sf	300sf/OCC	0 OCC
129 GARAGE	366 sf	300sf/OCC	2 OCC
130 STAIRS	216 sf	100sf/OCC	0 OCC
131 OFFICE	183 sf	100sf/OCC	2 OCC
132 RESTROOM	95 sf	100sf/OCC	0 OCC
133 STORAGE	69 sf	300sf/OCC	0 OCC
134 STAFF WORKROOM	1,866 sf	100sf/OCC	19 OCC
135 OFFICE	105 sf	100sf/OCC	2 OCC
136 OFFICE	99 sf	100sf/OCC	19 OCC
137 VESTIBULE	298 sf	100sf/OCC	0 OCC
138 OFFICE	146 sf	100sf/OCC	2 OCC
139 OFFICE	183 sf	100sf/OCC	2 OCC
UNOCCUPIABLE SPACE	971 sf		0 OCC
FIRST FLOOR TOTAL	23,354 sf**		408 OCC

**DOES NOT INCLUDE COURTYARD SQUARE FOOTAGE

NOTES THIS DRAWING:

1. SECOND FLOOR OCCUPANCY LOAD AT STAIR 113. TOTAL LOAD AT THIS EXIT = 64 OCC.
2. SECOND FLOOR OCCUPANCY LOAD AT STAIR 130. TOTAL LOAD AT THIS EXIT = 64 OCC.
3. METAL GATE W/ PANIC BAR. RE: FLOOR PLAN FOR ADDITIONAL DETAIL.

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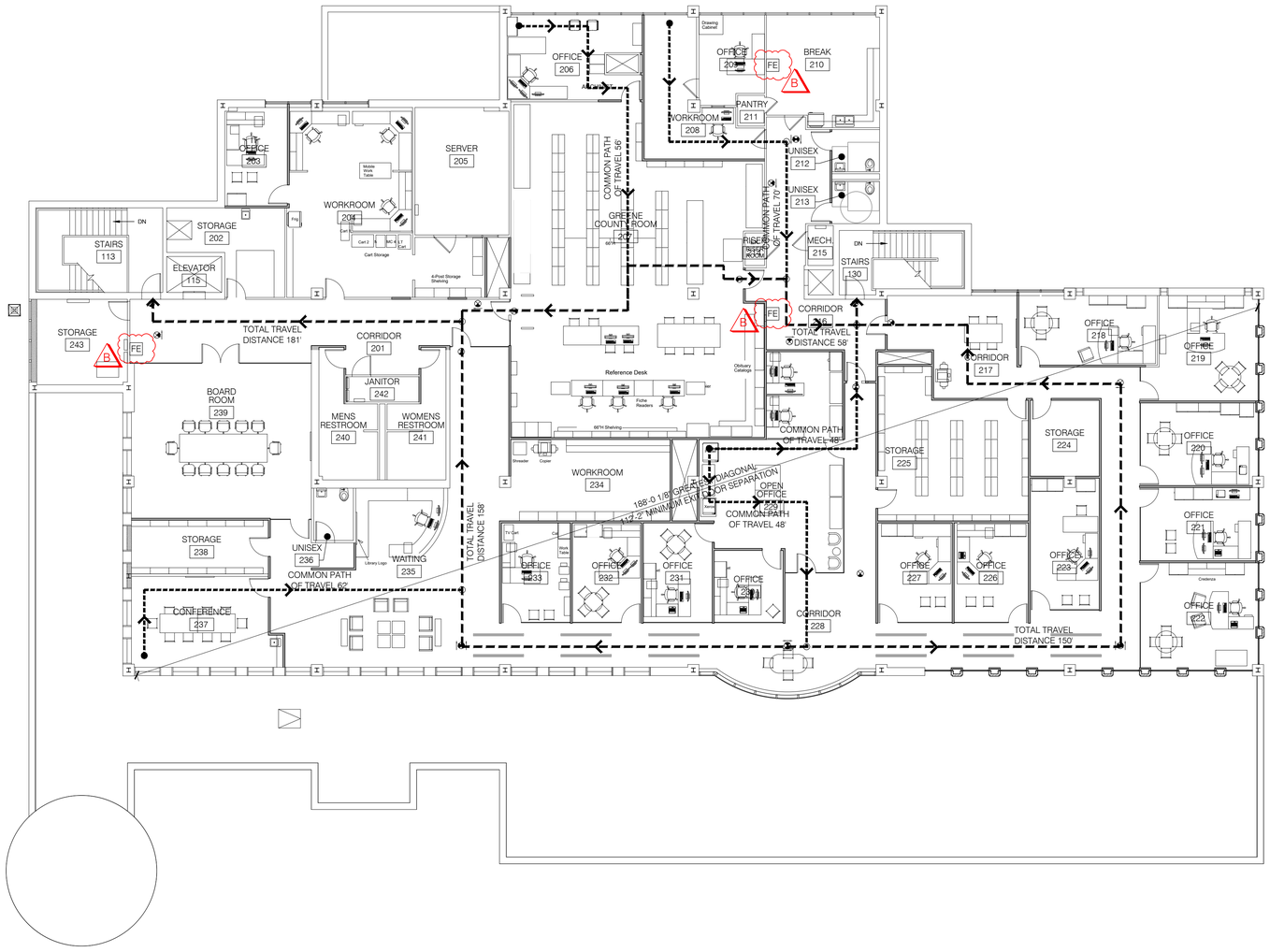
FIRST FLOOR
LIFE SAFETY PLAN AND CODE INFORMATION

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

LS101



2ND FLOOR
LIFE SAFETY PLAN
SCALE: 1/8"=1'-0"

1 / LS101

0 2 4 8 16
SCALE: 1/8" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. FIELD LOCATE PORTABLE FIRE EXTINGUISHERS WITH FIRE MARSHAL PER INTERNATIONAL FIRE CODE - CABINETS SHALL BE SURFACE MOUNTED U.N.O. B

LEGEND:

- EXIT ACCESS TRAVEL DISTANCE
- COMMON PATH OF EGRESS TRAVEL
- EXIT SIGN ON BATTERY BACKUP
- WALL MOUNTED EMERGENCY EGRESS LIGHT (BATTERY PACK WITH 2 HEADS)
- MOST REMOTE POINT
- POINT OF DECISION
- FE — FIRE EXTINGUISHER

B

OCCUPANT LOAD PER ROOM:

113 STAIRS	274 sf	100sf/OCC	0 OCC
115 ELEVATOR	51 sf	100sf/OCC	0 OCC
130 STAIRS	216 sf	100sf/OCC	0 OCC
201 CORRIDOR	582 sf	300sf/OCC	0 OCC
202 STORAGE	203 sf	300sf/OCC	0 OCC
203 IT OFFICE	154 sf	100sf/OCC	2 OCC
204 WORKROOM	710 sf	100sf/OCC	8 OCC
205 SERVER	302 sf	300sf/OCC	0 OCC
206 OFFICE	271 sf	100sf/OCC	3 OCC
207 GREENE COUNTY ROOM	1,943 sf	100sf/OCC	20 OCC
208 WORKROOM	263 sf	100sf/OCC	3 OCC
209 OFFICE	142 sf	100sf/OCC	2 OCC
210 BREAKROOM	310 sf	100sf/OCC	4 OCC
211 PANTRY	22 sf	100sf/OCC	0 OCC
212 RESTROOM	52 sf	100sf/OCC	0 OCC
213 RESTROOM	52 sf	100sf/OCC	0 OCC
214 RISER	16 sf	100sf/OCC	0 OCC
215 MECHANICAL	26 sf	300sf/OCC	0 OCC
216 CORRIDOR	416 sf	300sf/OCC	0 OCC
217 CORRIDOR	589 sf	300sf/OCC	0 OCC
218 OFFICE	244 sf	100sf/OCC	3 OCC
219 OFFICE	272 sf	100sf/OCC	3 OCC
220 OFFICE	242 sf	100sf/OCC	3 OCC
221 OFFICE	214 sf	100sf/OCC	3 OCC
222 OFFICE	306 sf	100sf/OCC	4 OCC
223 OFFICE	231 sf	100sf/OCC	3 OCC
224 STORAGE	133 sf	300sf/OCC	0 OCC
225 STORAGE	506 sf	300sf/OCC	0 OCC
226 OFFICE	187 sf	100sf/OCC	2 OCC
227 OFFICE	188 sf	100sf/OCC	2 OCC
228 CORRIDOR	1,098 sf	300sf/OCC	0 OCC
229 OPEN OFFICE	594 sf	100sf/OCC	6 OCC
230 OFFICE	126 sf	100sf/OCC	2 OCC
231 OFFICE	175 sf	100sf/OCC	2 OCC
232 OFFICE	175 sf	100sf/OCC	2 OCC
233 OFFICE	175 sf	100sf/OCC	2 OCC
234 WORKROOM	335 sf	100sf/OCC	4 OCC
235 WAITING AREA	1,146 sf	100sf/OCC	12 OCC
236 RESTROOM	53 sf	100sf/OCC	0 OCC
237 CONFERENCE ROOM	328 sf	100sf/OCC	4 OCC
238 STORAGE	187 sf	300sf/OCC	1 OCC
239 BOARD ROOM	705 sf	15sf/OCC	8 OCC
240 MENS RESTROOM	150 sf	100sf/OCC	0 OCC
241 WOMENS RESTROOM	150 sf	100sf/OCC	0 OCC
242 JANITOR	47 sf	100sf/OCC	1 OCC
243 STORAGE	208 sf	300sf/OCC	1 OCC
UNOCCUPIABLE SPACE	696 sf		0 OCC
TOTAL	15,465 sf		110 OCC

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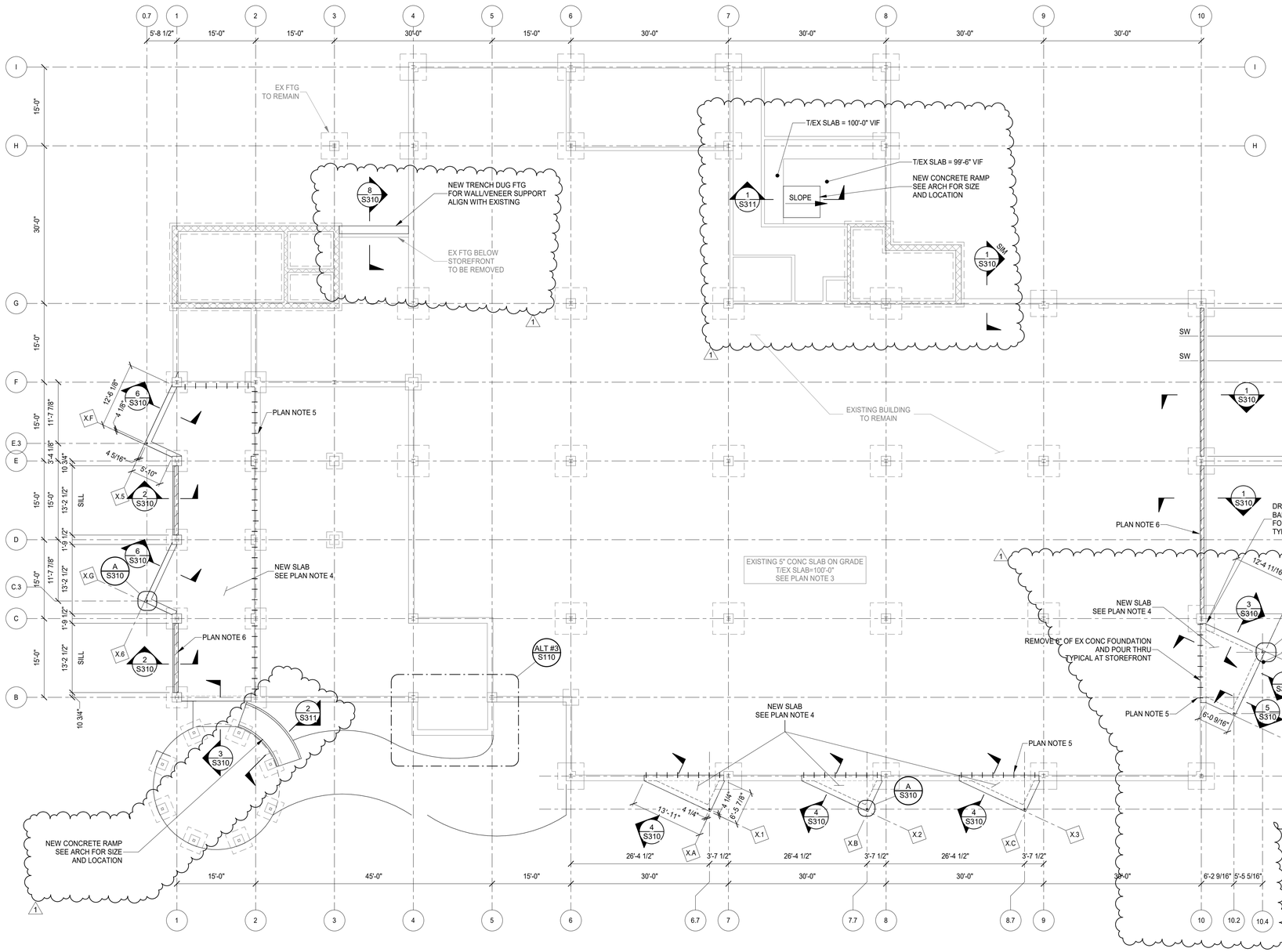
SECOND FLOOR
LIFE SAFETY PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

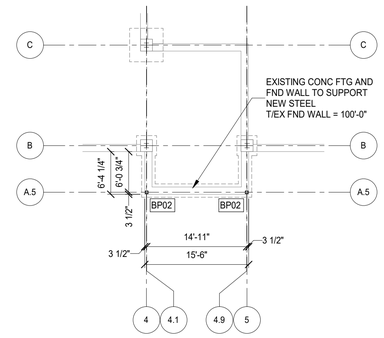
LS102

Filename : 21-2113_LS101.dwg Plot Date : Jan. 20, 2023 8:35am



FOUNDATION PLAN
SCALE 3/32" = 1'-0"

NORTH



ALTERNATE #3 FOUNDATION PLAN
SCALE 3/32" = 1'-0"

PLAN NOTES:

1. COORDINATE ALL DIMENSIONS, DOOR AND WINDOW LOCATIONS WITH ARCHITECTURAL DRAWINGS.
2. FIELD VERIFY ALL EXISTING CONDITIONS AND NOTIFY ADVANTAGE GROUP ENGINEERS OF ANY DISCREPANCIES.
3. T/EX SLAB = 100'-0" = 939.00' USGS. NEW SLAB ON GRADE TO MATCH EXISTING SLAB ON GRADE ELEVATION UNLESS NOTED OTHERWISE.
4. NEW 5" CONCRETE SLAB ON 4" COMPACTED GRANULAR FILL WITH W.W.F. 6x6xW2.9xW2.9 (42#) MESH CENTERED ON CHAIRS IN SLAB. T/SLAB = 100'-0" = MATCH EXISTING. COORDINATE CONTROL JOINTS PRIOR TO CONSTRUCTION.
5. DOWEL NEW SLAB TO EXISTING SLAB OR EXISTING GRADE BEAM WITH 1/2"Ø x12" LG SMOOTH DOWELS AT 24"o.c., 4" MIN EMBED.
6. NEW 8" CMU KNEEWALL FOR STOREFRONT SUPPORT. REINFORCE WITH #5's @ 32"o.c. VERTICAL, SEE SECTIONS 1/S310 AND 2/S310 FOR ADDITIONAL INFORMATION. COORDINATE HEIGHT WITH ARCH.
7. ALTERNATE #3 FOUNDATION PLAN PROVIDED ON THIS SHEET. SEE ALTERNATE #3 FRAMING PLAN ON S120.
8. SW = STEP WALL. SEE ARCH FOR STOREFRON WALL ELEVATIONS.

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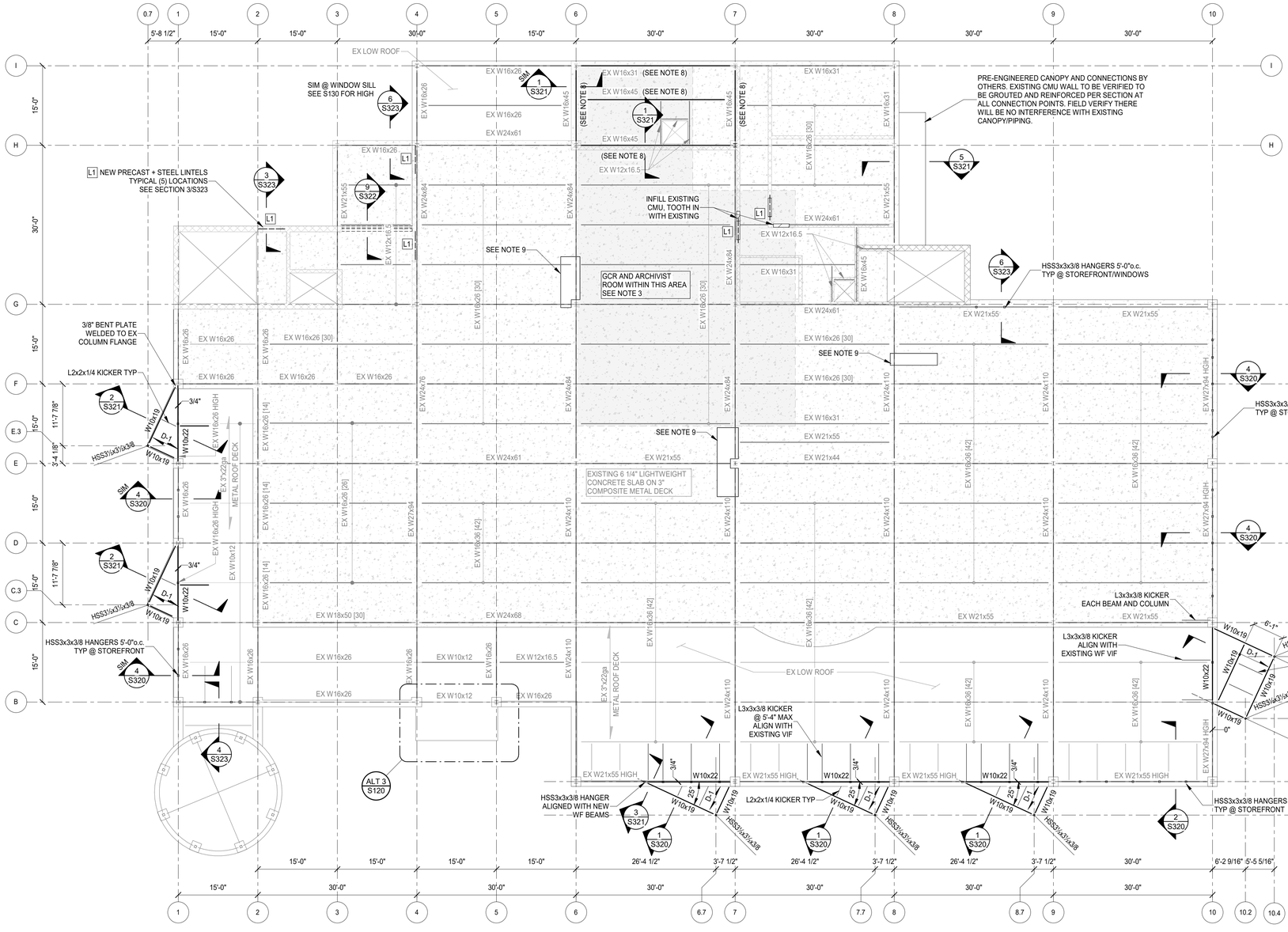
Cincinnati, Ohio 45206
Ph: (513) 396-8900

FOUNDATION PLAN

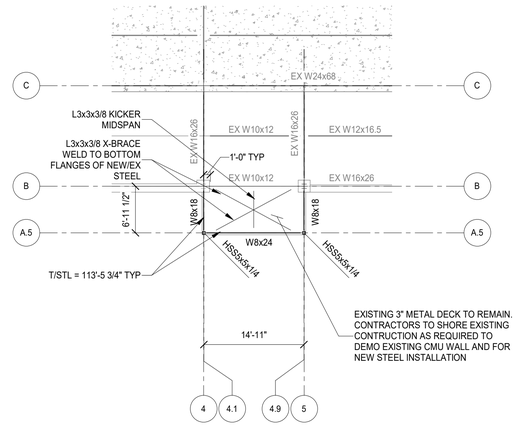
Drawn By:	ACL / SJ
Scale:	3/32" = 1'-0"
Job No.:	22131.05

S110



SECOND FLOOR FRAMING PLAN
SCALE 3/32" = 1'-0"

NORTH



ALTERNATE #3 FRAMING PLAN
SCALE 3/32" = 1'-0"

PLAN NOTES:

1. COORDINATE ALL DIMENSIONS, DOOR AND WINDOW LOCATIONS WITH ARCHITECTURAL DRAWINGS.
2. FIELD VERIFY ALL EXISTING CONDITIONS AND NOTIFY ADVANTAGE GROUP ENGINEERS (AGE) OF ANY DISCREPANCIES. EXISTING 2ND FLOOR CONSTRUCTION IS COMPOSITE STRUCTURAL STEEL.
3. EXISTING 2ND FLOOR SLAB AND FRAMING HAS BEEN ANALYZED BY AGE TO SUPPORT THE GREENE COUNTY ROOM (GCR). SEE PLAN AND REINFORCE EXISTING STEEL PER THIS PLAN PRIOR TO RE-LOCATING GCR. EXISTING STEEL CONNECTIONS WITHIN GCR AND ARCHIVIST ROOM TO BE FIELD VERIFIED BY GC AND REPORTED TO AGE FOR FINAL REVIEW.
4. T/EX 2ND FL SLAB = 114'-0" = 953.00' USGS, VIF.
5. T/STEEL = 109'-10" UNLESS NOTED OTHERWISE.
6. D-1 = 1½" x 20ga B DECK CUT TO FIT. FASTEN TO SUPPORTS WITH 5/8"Ø PUDDLE WELDS @ 12"o.c. AND PROVIDE (2) #10 SIDELAP SCREWS BETWEEN SUPPORTS.
7. COORDINATE WITH ARCHITECT REGARDING FIREPROOFING OF STRUCTURAL STEEL.
8. REINFORCE EXISTING STEEL BEAMS WITH NEW WT8x25 BELOW PER SECTION 1/S321. NEW WT8x25 REINFORCEMENT TO BE 10'-0" LONG AT 15'-0" SPANS AND 20'-0" LONG AT 30'-0" SPANS CENTERED.
9. COORDINATE CHASE OPENING WITHIN SLAB WITH MEP. SEE TYPICAL FLOOR OPENING DETAIL ON S320. UNDER NO CIRCUMSTANCES MAY A STRUCTURAL BEAM BE CUT TO INSTALL A MECHANICAL CHASE OPENING.

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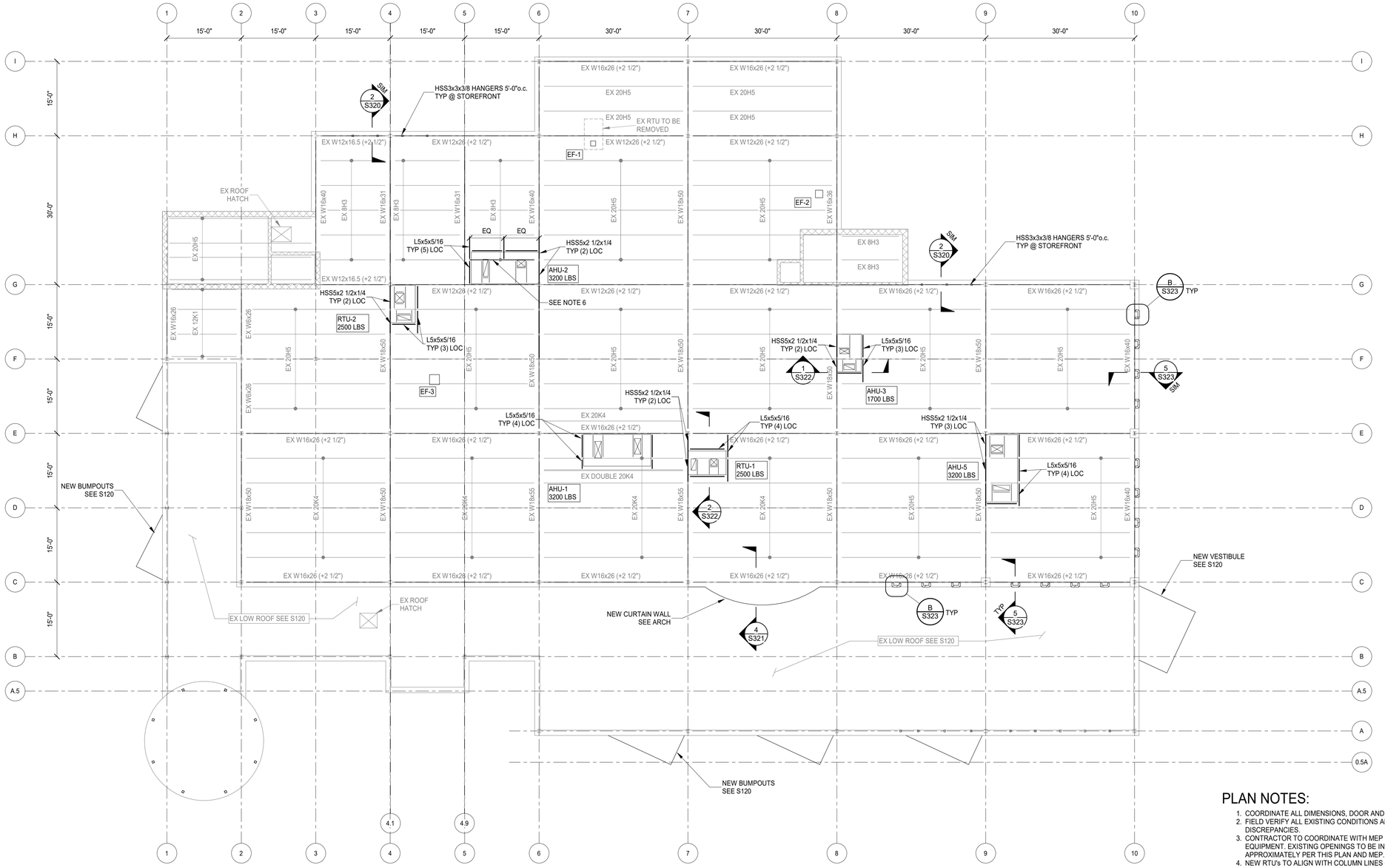
SECOND FLOOR FRAMING PLAN

Drawn By:	ACL / SJ
Scale:	3/32" = 1'-0"
Job No.:	22131.05

S120

1



ROOF FRAMING PLAN

SCALE 3/32" = 1'-0"

NORTH

PLAN NOTES:

1. COORDINATE ALL DIMENSIONS, DOOR AND WINDOW LOCATIONS WITH ARCHITECTURAL DRAWINGS.
2. FIELD VERIFY ALL EXISTING CONDITIONS AND NOTIFY ADVANTAGE GROUP ENGINEERS OF ANY DISCREPANCIES.
3. CONTRACTOR TO COORDINATE WITH MEP REGARDING REMOVAL OF EXISTING RTU's AND EQUIPMENT. EXISTING OPENINGS TO BE INFILLED WITH DECK PER S322. NEW RTU's TO BE PLACED APPROXIMATELY PER THIS PLAN AND MEP. COORDINATE SELECTION OF UNITS AND CURBS WITH MEP.
4. NEW RTU's TO ALIGN WITH COLUMN LINES (BEAMS) PER THIS PLAN, WITH HSS 5x2 1/2x1/4 SHIMS PLACED BETWEEN JOISTS FOR FULL CURB SUPPORT. PROVIDE ANGLE FRAMING BELOW UNIT AND AROUND OPENINGS PER THIS PLAN AND SECTIONS ON S322. MISCELLANEOUS ANGLE FRAMING AROUN OPENINGS TO BE L3x3x1/4 WITH L5x5x5/16 USED FOR MAIN CURB SUPPORT.
5. COORDINATE WITH MEP FOR EXACT LOCATIONS OF RTU'S AND DUCTWORK. COORDINATE DUCT SIZE WITH MEP TO AVOID INTERFERENCE WITH EXISTING JOISTS. UNDER NO CIRCUMSTANCE MAY AN EXISTING JOIST BE CUT OR MODIFIED TO ALLOW DUCTWORK TO PASS.
6. EXISTING 8H3 JOIST BELOW AHU-2 TO BE REINFORCED WITH (2) 1/2"Ø RODS TOP AND BOTTOM CHORD AND L1 1/2x1 1/2x3/16 ANGLES AT WEBS. SEE S323 FOR APPLICABLE SECTIONS. CONTRACTORS TO FIELD VERIFY EXISTING JOIST CONSTRUCTION (RODS, ANGLES, CRIMPS, ETC.) PRIOR TO CONSTRUCTION TO ENSURE PROPOSED METHOD OF REINFORCEMENT WILL WORK FOR THE TYPE OF JOIST.

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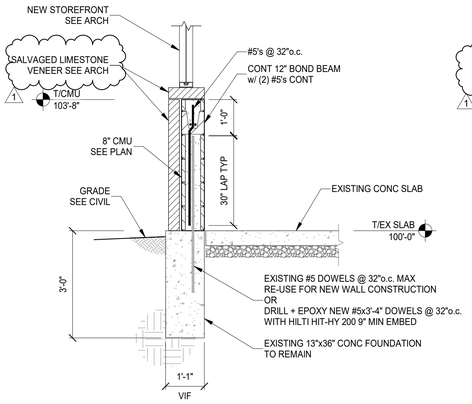
ROOF FRAMING PLAN

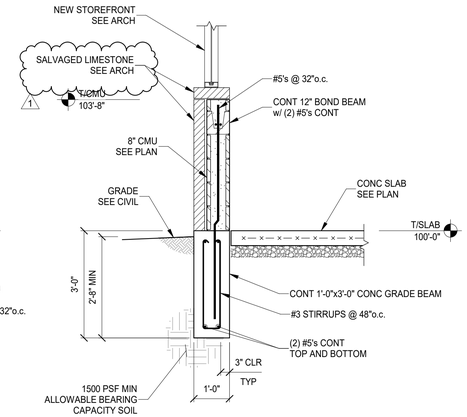
Drawn By:	ACL / SJ
Scale:	3/32" = 1'-0"
Job No.:	22131.05

S130

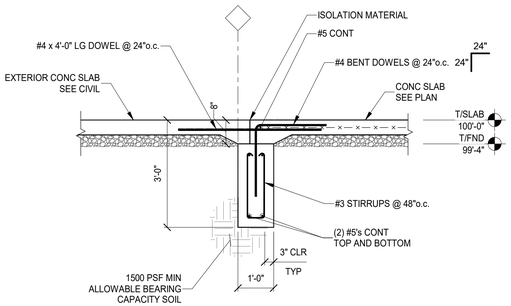
1



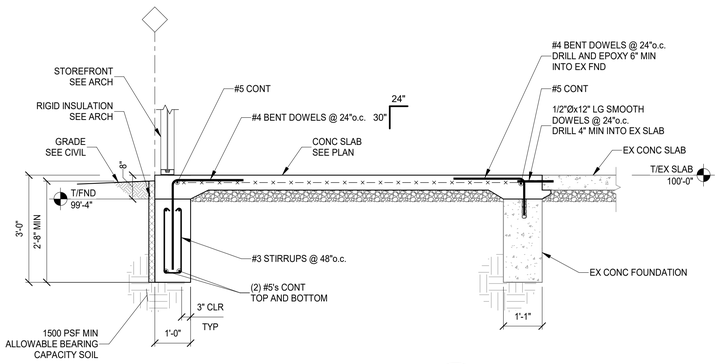
SECTION 1
SCALE 1/2" = 1'-0" S310



SECTION 2
SCALE 1/2" = 1'-0" S310



SECTION 3
SCALE 1/2" = 1'-0" S310



SECTION 4
SCALE 1/2" = 1'-0" S310

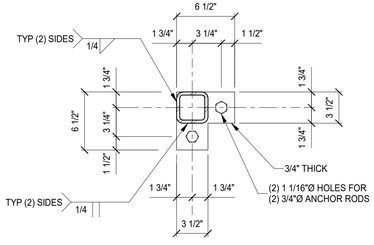
SECTION 5
SCALE 1/2" = 1'-0" S310

PLAN DETAIL A
SCALE 1 1/2" = 1'-0" S310

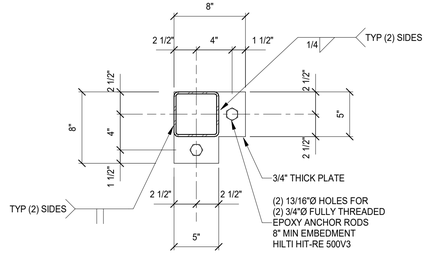
SECTION 6
SCALE 1/2" = 1'-0" S310

SECTION 7
SCALE 1/2" = 1'-0" S310

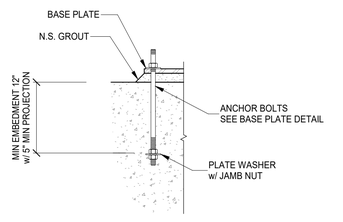
SECTION 8
SCALE 1/2" = 1'-0" S310



BP01 - HSS3½x3½ BASE PLATE DETAIL
SCALE 1 1/2" = 1'-0"



BP02 - HSS5x5 BASE PLATE DETAIL
SCALE 1 1/2" = 1'-0"



TYPICAL ANCHOR BOLT DETAIL
SCALE 1" = 1'-0"

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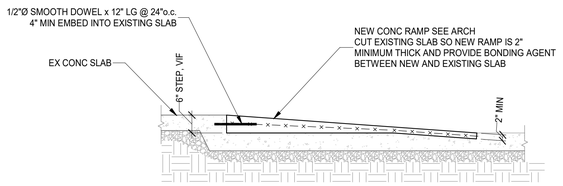
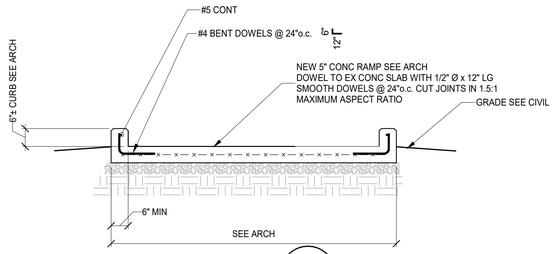
FOUNDATION SECTIONS

Drawn By:	ACL / SJ
Scale:	As indicated
Job No.:	22131.05

S310



SECTION 1 / S311
SCALE 1/2" = 1'-0"



SECTION 2 / S311
SCALE 1/2" = 1'-0"

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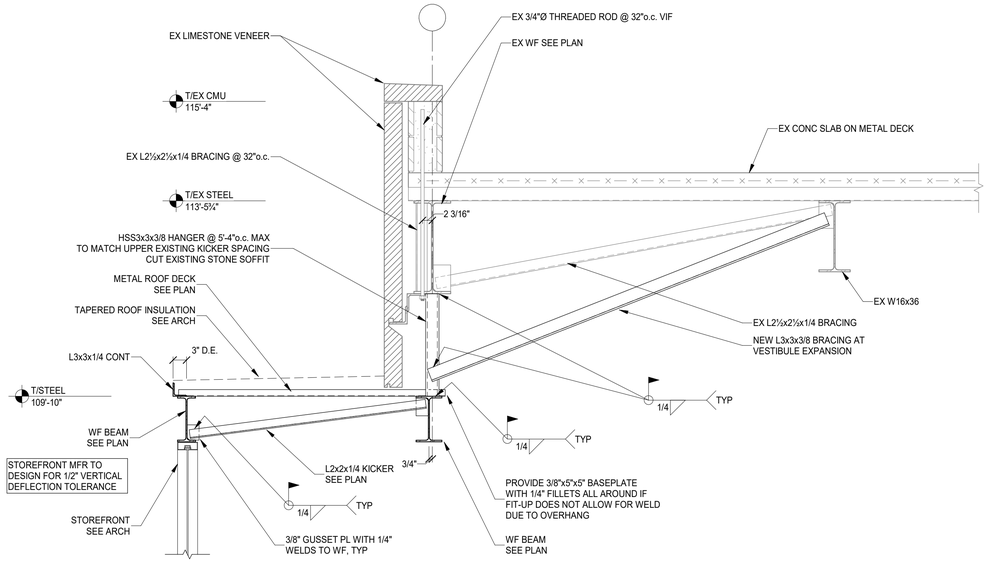
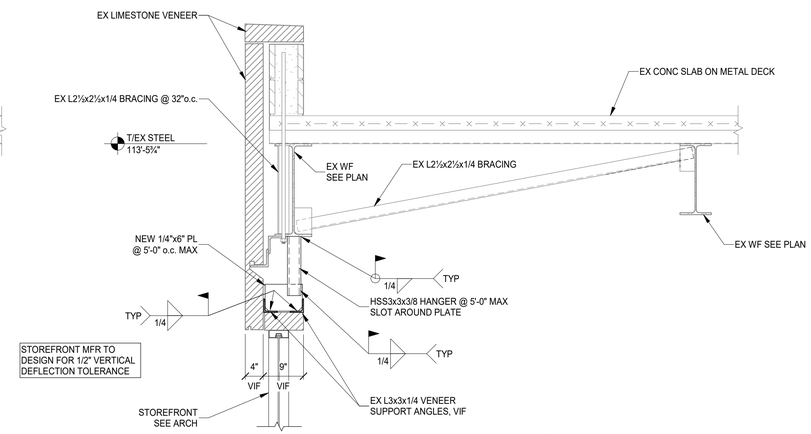
Job No.:	22131.05

S311



SECTION 1
SCALE 3/4" = 1'-0" S320



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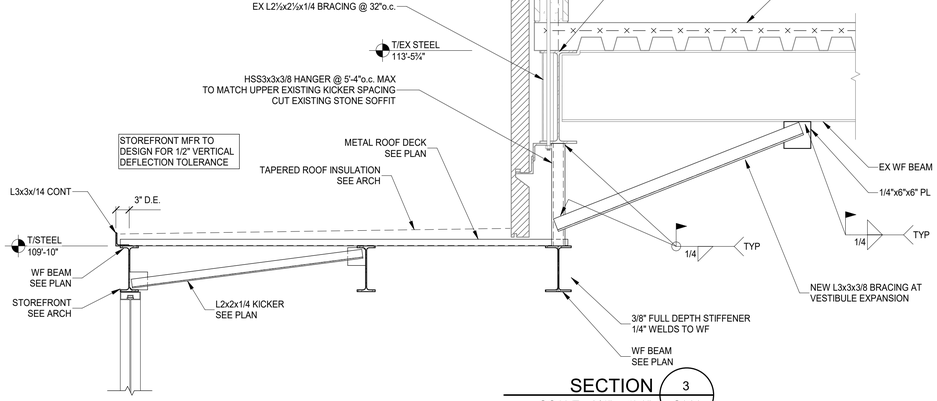

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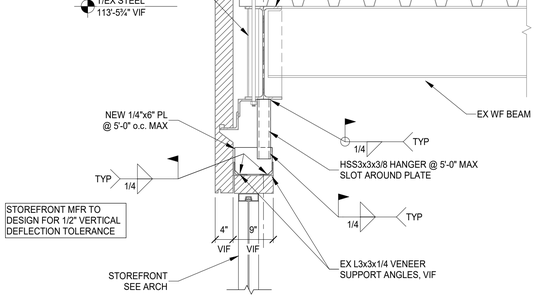
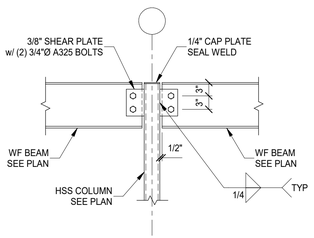
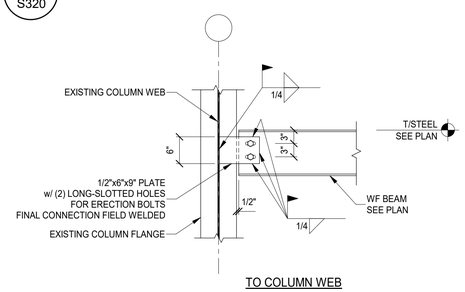


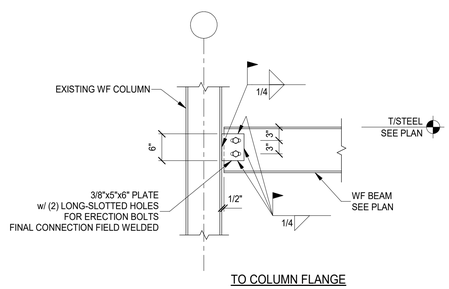
SECTION 4
SCALE 3/4" = 1'-0" S320



TYPICAL WF BEAM TO HSS COL CONNECTION
SCALE 3/4" = 1'-0"

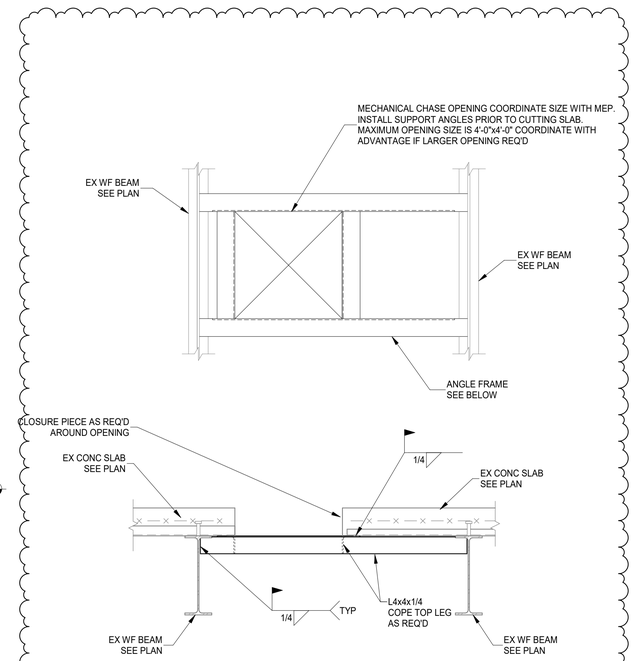


TO COLUMN WEB



TO COLUMN FLANGE

TYPICAL SHEAR CONNECTION TO EXISTING COLUMN
SCALE 3/4" = 1'-0"



TYPICAL FLOOR OPENING FRAMING
SCALE 3/4" = 1'-0"

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ADVANTAGE GROUP ENGINEERS, INC.
1527 Madison Rd.
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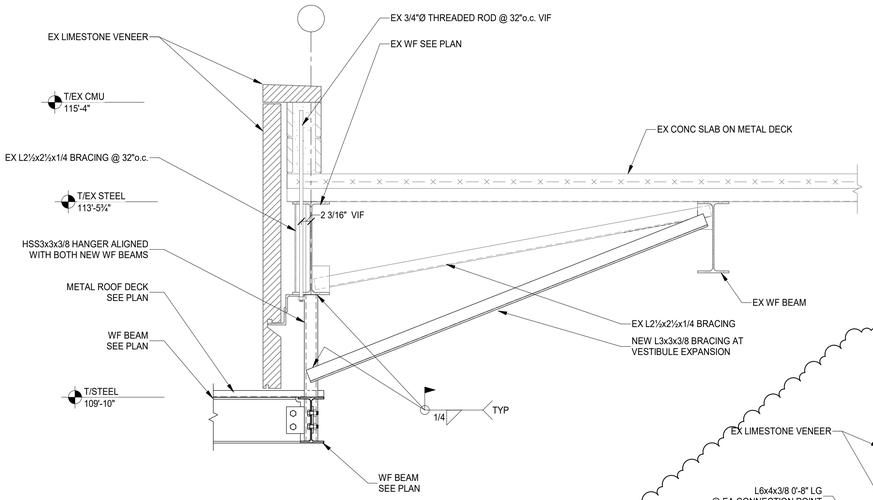
Ph: (513) 396-8900

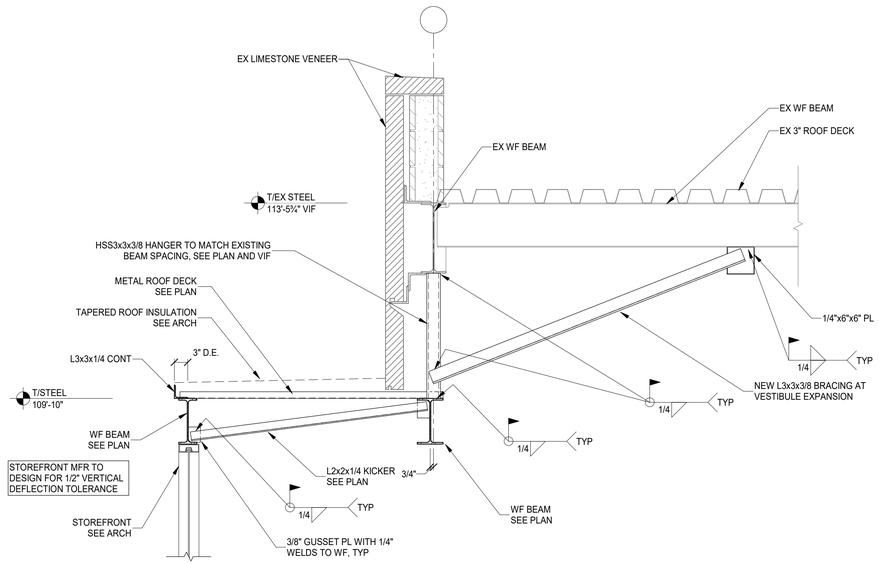
FRAMING SECTIONS

Drawn By:	ACL / SJ
Scale:	3/4" = 1'-0"
Job No.:	22131.05

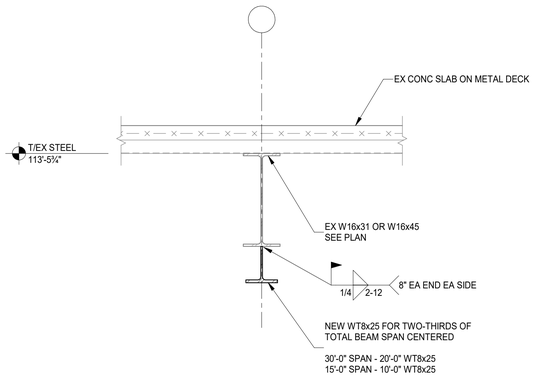
S320



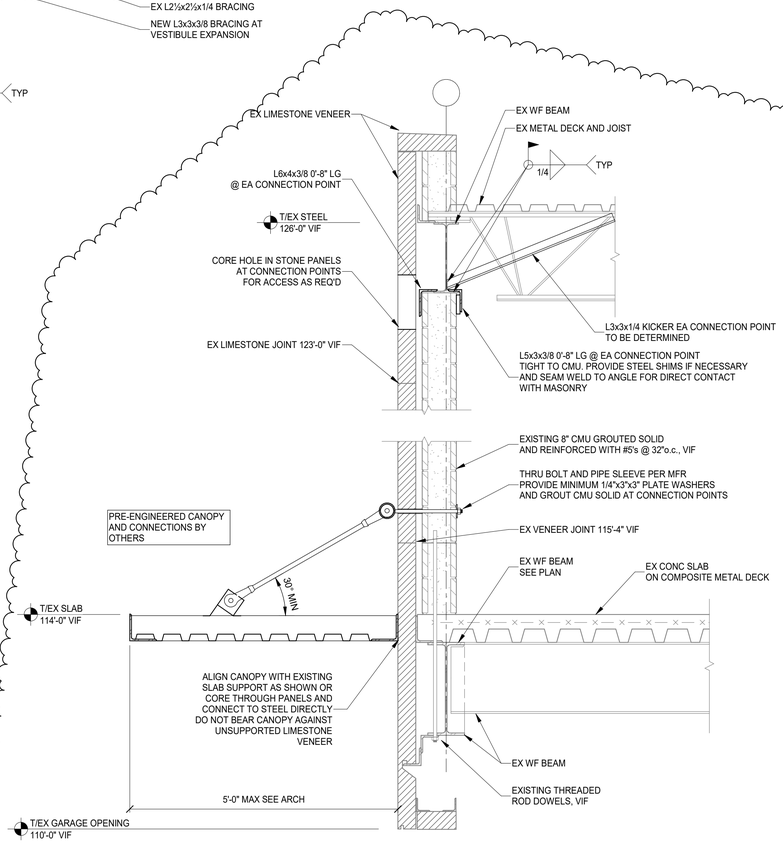
SECTION 3
SCALE 3/4" = 1'-0" S321



SECTION 2
SCALE 3/4" = 1'-0" S321



SECTION 1
SCALE 3/4" = 1'-0" S321



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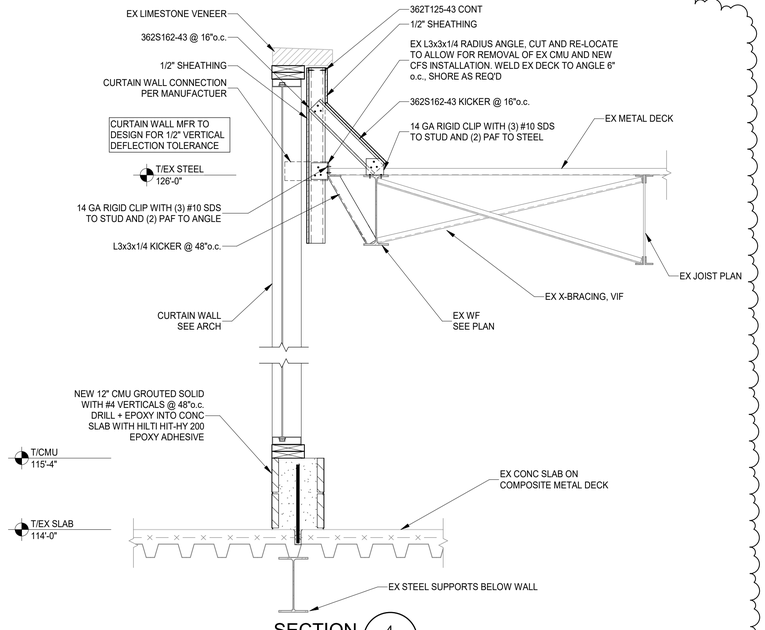
SCALE 3/4" = 1'-0" S321



SECTION 4
SCALE 3/4" = 1'-0" S321

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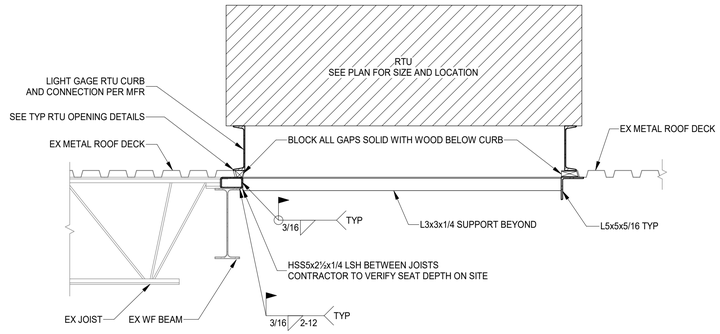
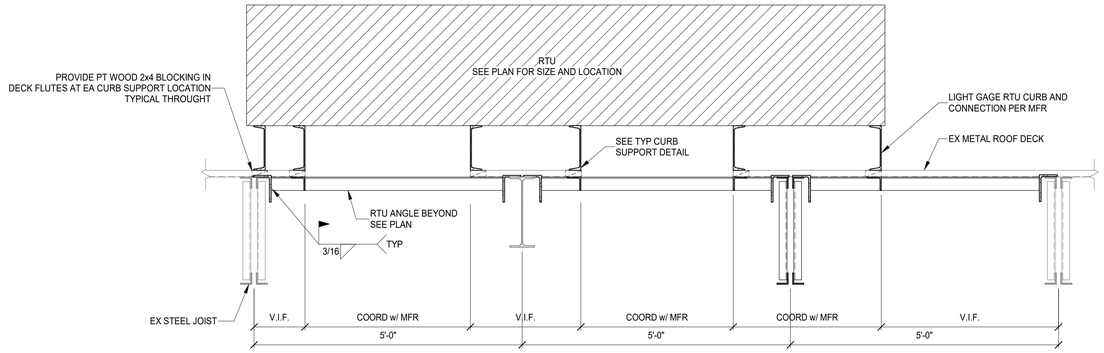
FRAMING SECTIONS

Drawn By:	ACL / SJ
Scale:	3/4" = 1'-0"
Job No.:	22131.05

S321



SECTION 1 / S322
SCALE 3/4" = 1'-0"



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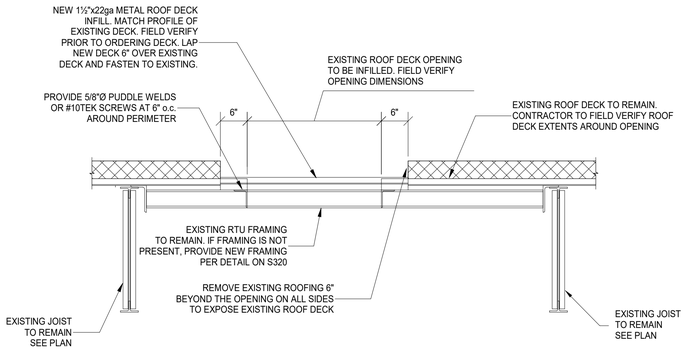
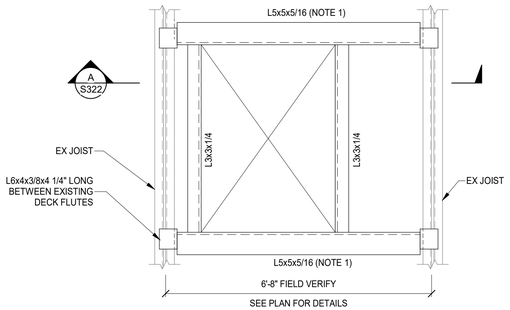
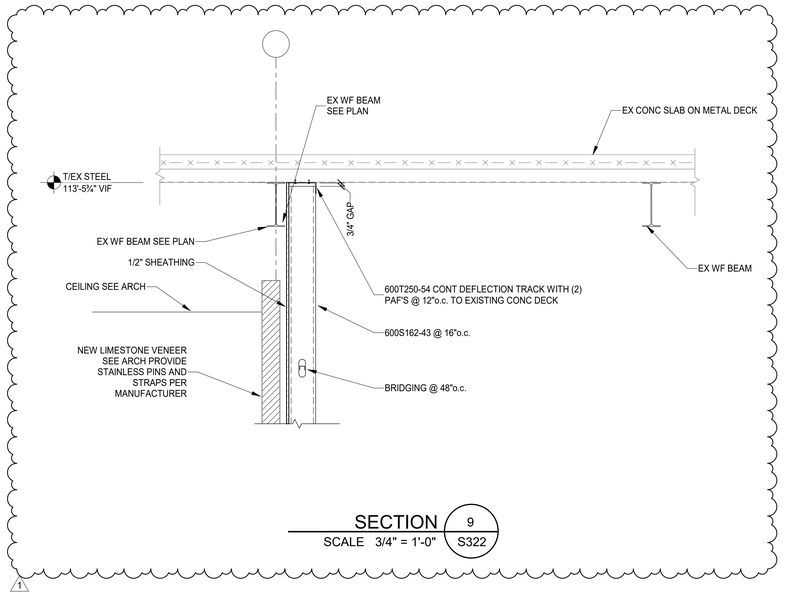


TYPICAL ROOF DECK INFILL
SCALE 3/4" = 1'-0"

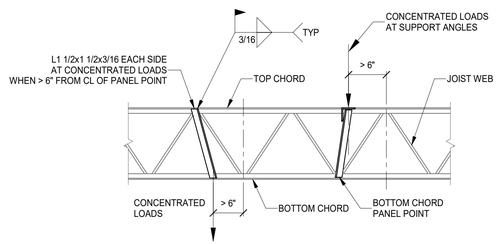


NOTES:
1. FLIP ANGLE AS REQUIRED SUCH THAT THE VERTICAL LEG ALIGNS WITH THE L6x4x3/8 SUPPORT. COPE ANGLE AS REQUIRED

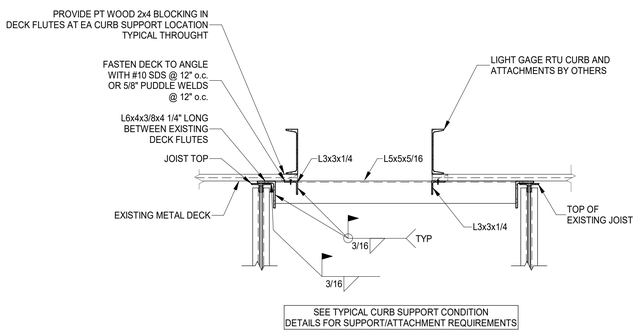
TYPICAL SUPPORT OF HVAC UNIT
SCALE 3/4" = 1'-0"



SECTION 9 / S322
SCALE 3/4" = 1'-0"

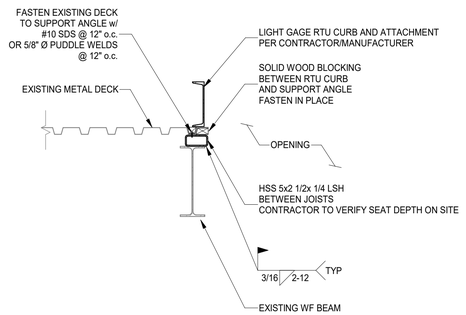


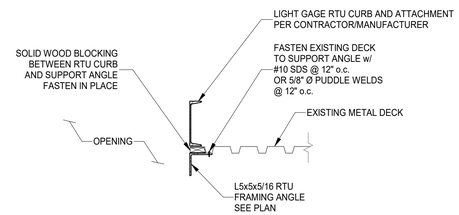
TYPICAL SUPPORT OF CONCENTRATED LOADS
SCALE 3/4" = 1'-0"



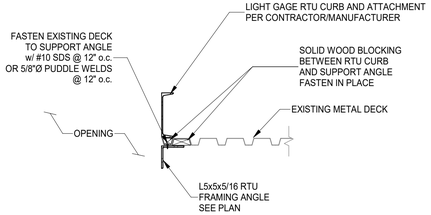
SEE TYPICAL CURB SUPPORT CONDITION
DETAILS FOR SUPPORT/ATTACHMENT REQUIREMENTS

SECTION A / S322
SCALE 3/4" = 1'-0"





TYPICAL RTU OPENING DETAIL PARALLEL TO ROOF DECK - CONDITION 1
SCALE 3/4" = 1'-0"



TYPICAL RTU OPENING DETAIL PARALLEL TO DECK - CONDITION 2
SCALE 3/4" = 1'-0"

TYPICAL RTU OPENING DETAIL PARALLEL TO DECK - CONDITION 3
SCALE 3/4" = 1'-0"

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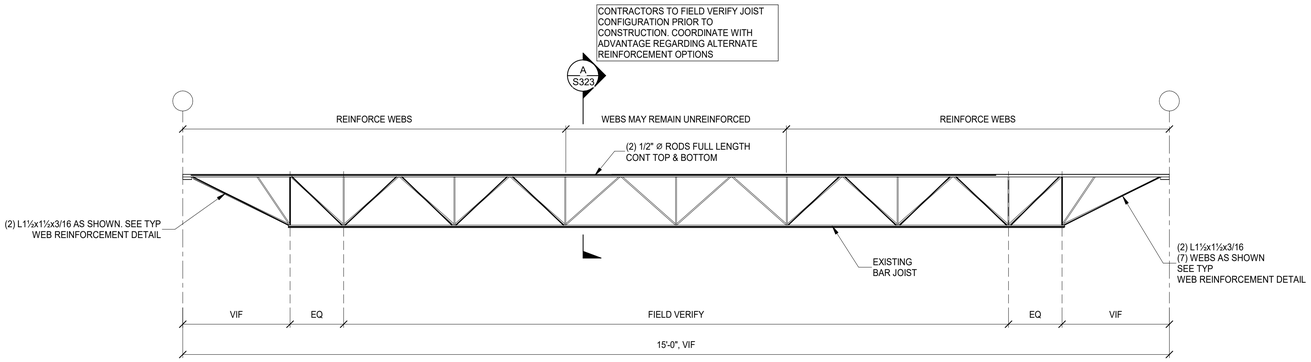
FRAMING SECTIONS

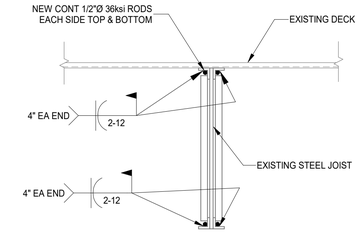
Drawn By:	ACL / SJ
Scale:	3/4" = 1'-0"
Job No.:	22131.05

S322



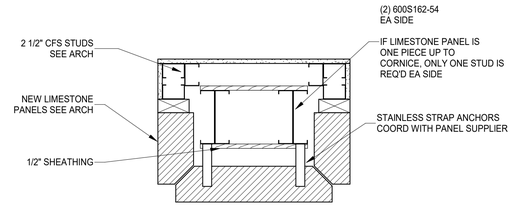
TYPICAL 8H3 JOIST REINFORCEMENT

SCALE 3/8" = 1'-0"



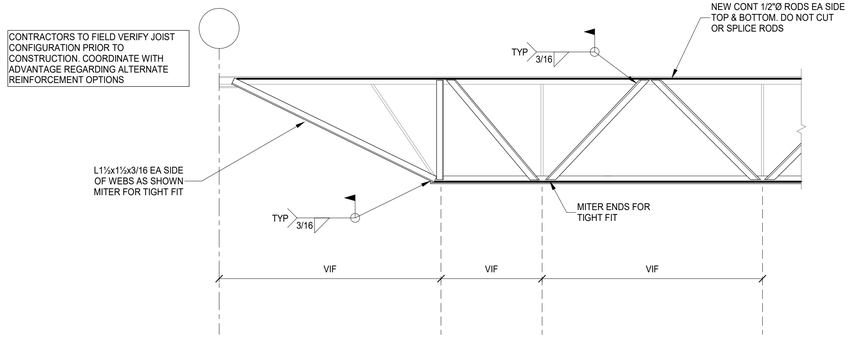
SECTION A / S323

SCALE 1 1/2" = 1'-0"



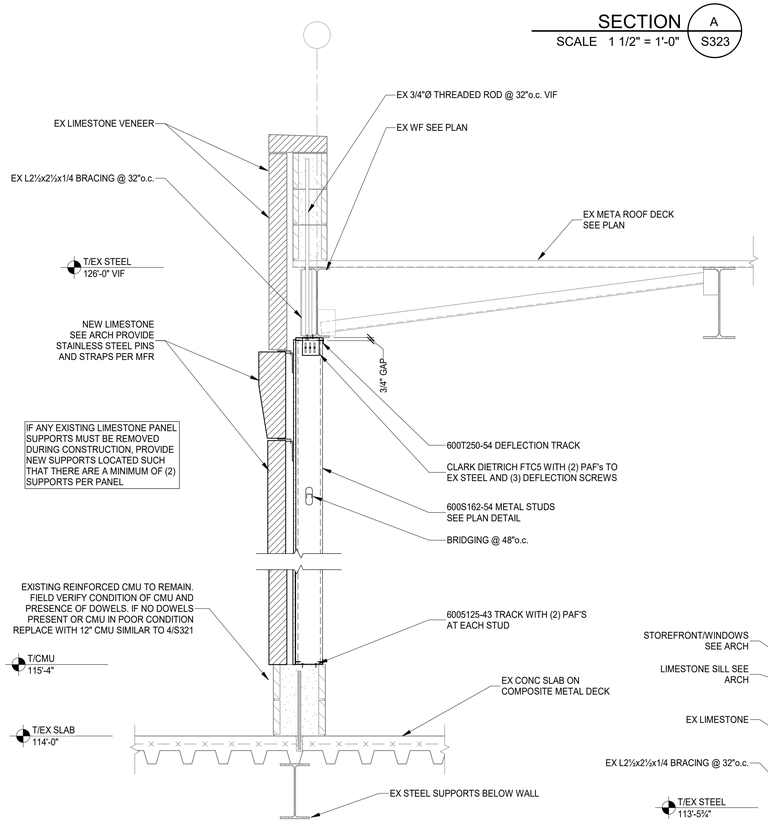
PLAN DETAIL B / S323

SCALE 1 1/2" = 1'-0"



TYPICAL WEB REINFORCEMENT DETAIL

SCALE 3/4" = 1'-0"



SECTION 5 / S323

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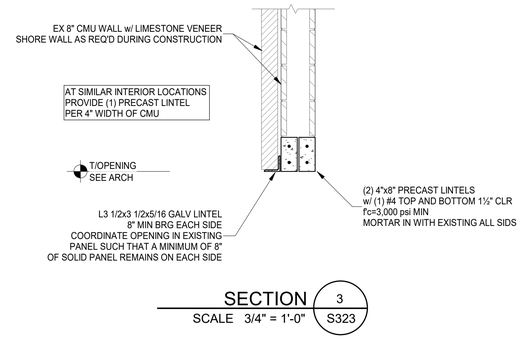

SECTION 3 / S323

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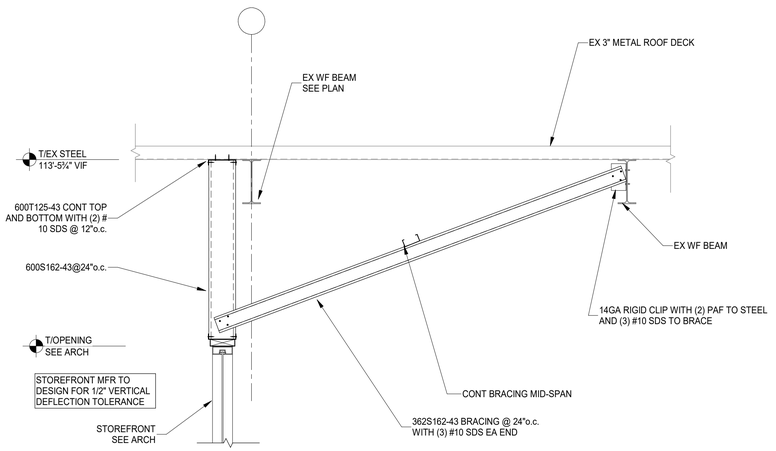

SECTION 4 / S323

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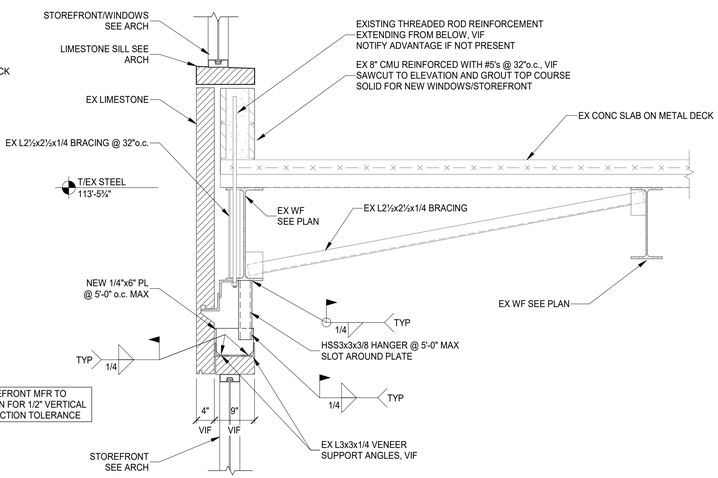

SECTION 6 / S323

SCALE 3/4" = 1'-0"

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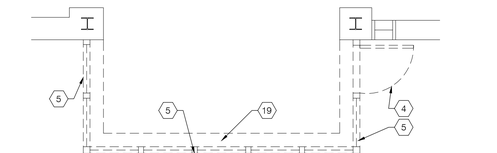
FRAMING SECTIONS

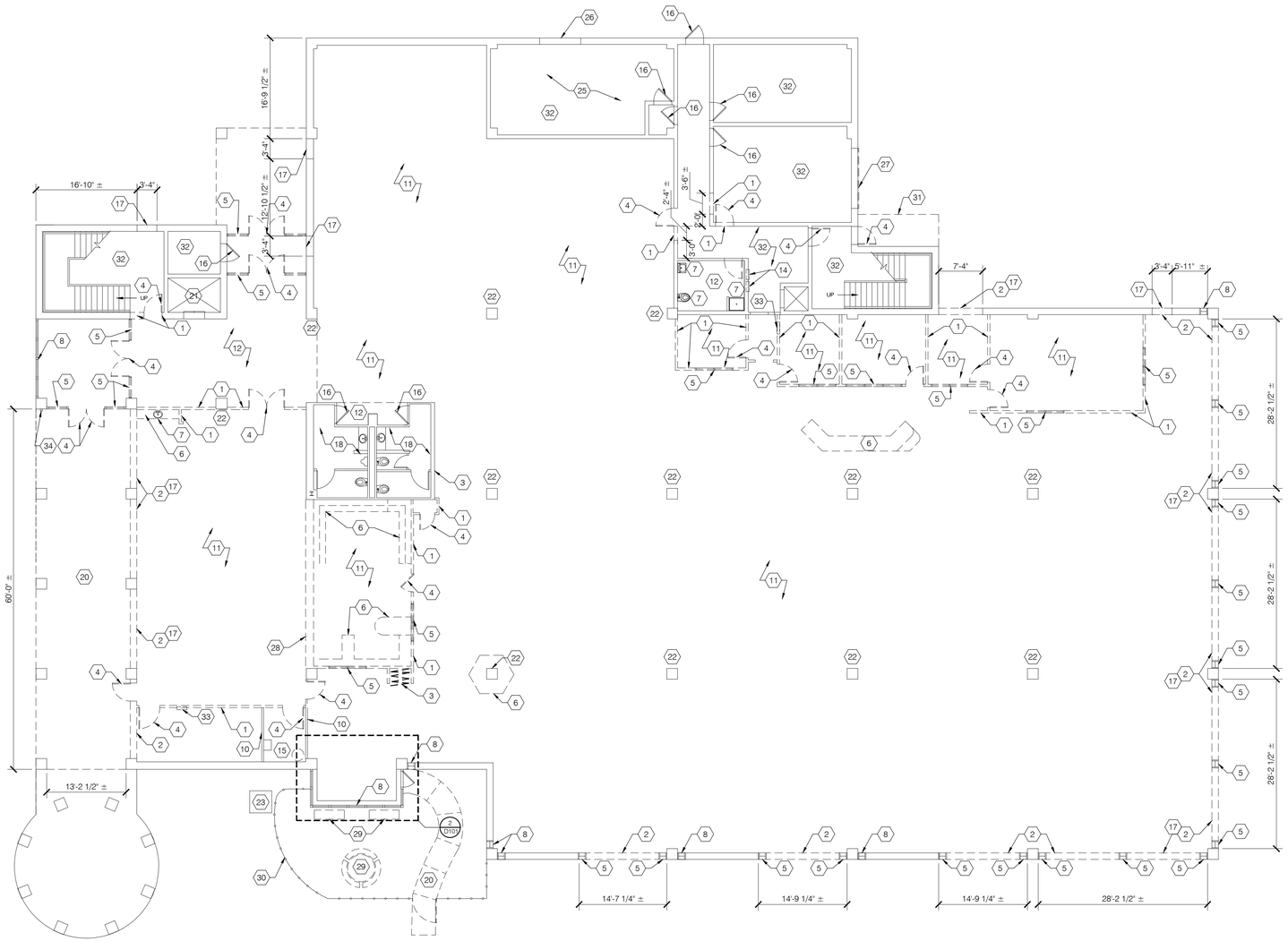
Drawn By:	ACL / SJ
Scale:	As indicated
Job No.:	22131.05

S323



2 / D101 ALTERNATE #3 - DEMO PLAN
SCALE: 1/4"=1'-0"

B



1 / D101 FIRST FLOOR DEMO PLAN
SCALE: 3/32"=1'-0"

B

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. DASHED LINES INDICATE ITEMS TO BE REMOVED.
C. DISPOSE OF ALL MATERIAL PROPERLY. SEE SPECIFICATIONS.
D. REMOVE WALLS, CEILINGS, FLOOR FINISHES, WALL FINISHES, AND OTHER MATERIAL OR COMPONENTS ONLY AS REQUIRED FOR INSTALLATION OF NEW WORK AND CONSISTENT WITH THE INTENT OF THE CONSTRUCTION DOCUMENTS, ALTHOUGH SOME ITEMS MAY NOT BE SPECIFICALLY ADDRESSED.
E. WHERE NEW FINISHES ARE INDICATED ON REMAINING EXISTING STRUCTURE, REMOVE EXISTING FINISHES AS REQUIRED TO ALLOW FOR NEW FINISHES. PREPARE ALL SURFACES TO RECEIVE NEW WORK.
F. ~~SEE PLUMBING DRAWINGS FOR PLUMBING DEMOLITION.~~
G. SEE ELECTRICAL DRAWINGS FOR ELECTRICAL / IT DEMOLITION.
H. ~~SEE MECHANICAL DRAWINGS FOR MECHANICAL DEMOLITION.~~
I. PATCH, REPAIR AND PREP ALL WALLS AS NECESSARY THAT ARE TO RECEIVE NEW FINISHES. REFER TO FLOOR PLAN FOR ADDITIONAL INFORMATION.
J. REMOVE ALL WALL BASE FROM WALLS IN AREAS OF WORK WHERE FLOORING IS REMOVED.
K. PROTECT ALL EXISTING ITEMS TO REMAIN FROM DAMAGE DURING CONSTRUCTION. FIXTURES, WALLS, CASEWORK, EQUIPMENT, AND DEVICES.
L. REMOVE ALL EXISTING DRYWALL IN MAIN FLOOR AREA. NEW DRYWALL SHALL BE INSTALLED PER FLOOR PLAN TO ACCOMMODATE/MATCH NEW CONSTRUCTION. EXTEND FRAMING AS NECESSARY TO ACCOMMODATE NEW DRYWALL.
M. OWNERS VENDOR RESPONSIBLE FOR DEMOLITION/RELOCATION OF ALL EXISTING SHELVING EXCEPT WHERE NOTED. COORDINATE WITH OWNER PRIOR TO DISPOSAL OF ANY REMAINING SHELVING ITEMS.

B

NOTES THIS DRAWING:

1. REMOVE EXISTING WALL PARTITION.
2. REMOVE EXISTING LIMESTONE OR CONCRETE PANELS, CMU, AND ASSOCIATED CONNECTORS. SALVAGE LIMESTONE PANELS, REFER TO FLOOR PLANS FOR NEW LOCATION.
3. REMOVE FOLDABLE PARTITION WALL AND ALL ASSOCIATED HARDWARE.
4. REMOVE EXISTING DOOR, FRAME, AND ALL ASSOCIATED HARDWARE.
5. REMOVE EXISTING ALUMINUM STOREFRONT AND ALL ASSOCIATED HARDWARE.
6. REMOVE EXISTING CASEWORK/SHELVING.
7. REMOVE EXISTING PLUMBING FIXTURES AND ACCESSORIES. REFER TO PLUMBING DRAWINGS FOR DETAILS.
8. EXISTING GLAZING TO REMAIN. PROTECT THROUGHOUT CONSTRUCTION.
9. REMOVE EXISTING DRYWALL AND FURRING.
10. PORTION OF EXISTING WALL PARTITION TO REMAIN.
11. REMOVE EXISTING CARPET, PAD, ADDITIONAL UNDERLAYMENT, AND ADHESIVE (IF APPLICABLE) FOR NEW FLOORING. REFER TO INTERIOR FINISH PLANS FOR NEW FLOORING MATERIAL AND LOCATION. PREP SLAB FOR NEW FLOORING AS REQUIRED.
12. REMOVE EXISTING VINYL/TILE FLOORING AND UNDERLAYMENT AS NEEDED FOR NEW FLOORING. REFER TO INTERIOR FINISH PLANS FOR NEW FLOORING MATERIAL AND LOCATION. PREP SLAB FOR NEW FLOORING AS REQUIRED.
13. REMOVE STAGE.
14. EXISTING ELECTRICAL PANEL TO REMAIN. REFER TO ELECTRICAL DRAWINGS.
15. EXISTING WATER SERVICE TO REMAIN. REFER TO PLUMBING DRAWINGS.
16. EXISTING DOOR TO REMAIN.
17. REMOVE PORTION OF EXISTING MASONRY WALL FOR NEW WINDOW/DOOR. SHORE EXISTING STRUCTURE AS REQUIRED TO INSTALL NEW LINTEL. SEE FLOOR PLAN AND STRUCTURAL DRAWINGS FOR ADDITIONAL INFORMATION.
18. EXISTING RESTROOM TO REMAIN.
19. REMOVE CMU BEARING WALL. SHORE AS NECESSARY FOR NEW CONSTRUCTION PER ALTERNATE #3, RE: STRUCTURAL DRAWINGS FOR ADDITIONAL DETAIL.
20. REMOVE EXISTING SIDE WALK IN PREP FOR NEW FLOOR SLAB. RE: CIVIL DRAWINGS FOR ADDITIONAL DETAIL. SEE STRUCTURAL DRAWINGS FOR CONNECTION DETAILS TO EXISTING SLAB.
21. EXISTING ELEVATOR CAB TO REMAIN. DEMO ELEVATOR COMPONENTS AS NECESSARY FOR ELEVATOR MODERNIZATION. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
22. REMOVE DRYWALL FROM EXISTING COLUMN, TYPICAL. SEE GENERAL NOTE "L".
23. EXISTING WATER SERVICE HATCH TO REMAIN. RE: A/001 FOR ADDITIONAL DETAIL.
24. REMOVE EXISTING CONCRETE PAD. INSTALL PER NEW.
25. REMOVE EXISTING MECHANICAL EQUIPMENT. RE: MEP DRAWINGS FOR ADDITIONAL DETAIL.
26. REMOVE EXISTING GRILLE AS NEEDED FOR INSTALLATION OF NEW BIRD SCREEN. CLEAN GRILLE PRIOR TO REINSTALLING.
27. REMOVE AND REPLACE EXISTING OVERHEAD GARAGE DOOR.
28. REMOVE EXISTING CMU WALL. SHORE AS NECESSARY FOR NEW CONSTRUCTION. RE: STRUCTURAL DRAWINGS.
29. EXISTING PATIO FURNITURE TO REMAIN. RELOCATE AS NECESSARY FOR INSTALLATION OF NEW PATIO. COORDINATE WITH OWNER FOR FINAL LOCATION.
30. REMOVE EXISTING FENCE. RE: SITE PLAN FOR ADDITIONAL DETAIL.
31. REMOVE EXISTING AWNING OVERHEAD. RE: DEMO ELEVATIONS FOR ADDITIONAL DETAIL.
32. EXISTING FLOORING TO REMAIN.
33. RELOCATE EXISTING ELECTRICAL PANEL. REFER TO ELECTRICAL DRAWINGS FOR FINAL LOCATION.
34. RELOCATE KNOX BOX. REFER TO FLOOR PLAN FOR FINAL KNOX BOX LOCATION.

B

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COMPLETE RENOVATION/MECHANICAL UPGRADES:

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PRELIMINARY BID
NOT FOR
CONSTRUCTION

FIRST FLOOR
DEMOLITION PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

D101

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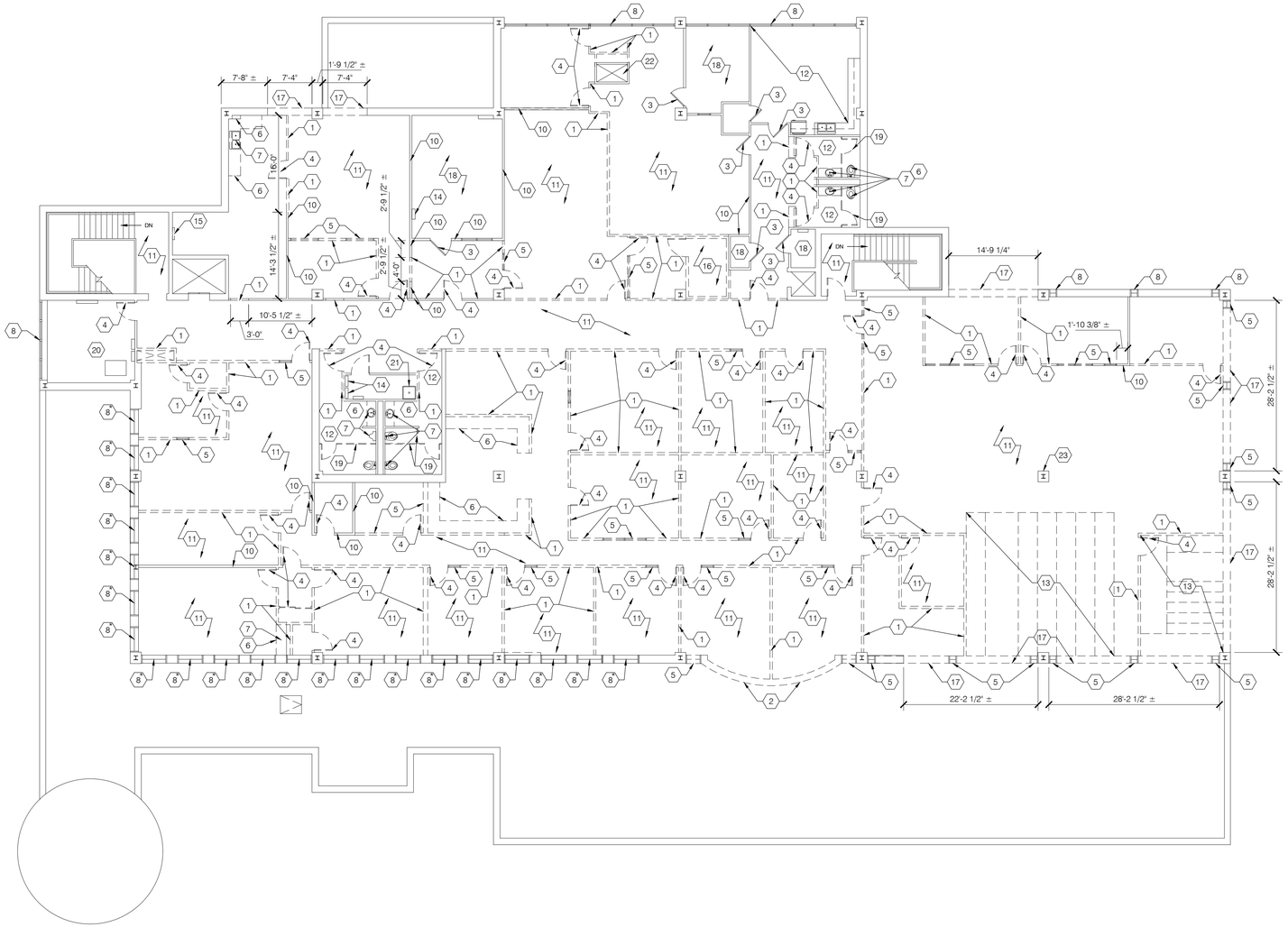
Filename : 21-2113_D101.dwg Plot Date : Jan. 20, 2023 8:14am



1 D102 SECOND FLOOR DEMO PLAN
SCALE: 3/32"=1'-0" B

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. DASHED LINES INDICATE ITEMS TO BE REMOVED.
C. DISPOSE OF ALL MATERIAL PROPERLY. SEE SPECIFICATIONS.
D. REMOVE WALLS, CEILINGS, FLOOR FINISHES, WALL FINISHES, AND OTHER MATERIAL OR COMPONENTS ONLY AS REQUIRED FOR INSTALLATION OF NEW WORK AND CONSISTENT WITH THE INTENT OF THE CONSTRUCTION DOCUMENTS, ALTHOUGH SOME ITEMS MAY NOT BE SPECIFICALLY ADDRESSED.
E. WHERE NEW FINISHES ARE INDICATED ON REMAINING EXISTING STRUCTURE, REMOVE EXISTING FINISHES AS REQUIRED TO ALLOW FOR NEW FINISHES. PREPARE ALL SURFACES TO RECEIVE NEW WORK.
F. ~~SEE PLUMBING DRAWINGS FOR PLUMBING DEMOLITION.~~
G. SEE ELECTRICAL DRAWINGS FOR ELECTRICAL / IT DEMOLITION.
H. ~~SEE MECHANICAL DRAWINGS FOR MECHANICAL DEMOLITION.~~ B
I. PATCH, REPAIR AND PREP ALL WALLS AS NECESSARY THAT ARE TO RECEIVE NEW FINISHES. REFER TO FLOOR PLAN FOR ADDITIONAL INFORMATION.
J. REMOVE ALL WALL BASE FROM WALLS IN AREAS OF WORK WHERE FLOORING IS REMOVED.
K. PROTECT ALL EXISTING ITEMS TO REMAIN FROM DAMAGE DURING CONSTRUCTION, FIXTURES, WALLS, CASEWORK, EQUIPMENT, AND DEVICES.
L. REMOVE ALL EXISTING DRYWALL IN MAIN FLOOR AREA. NEW DRYWALL SHALL BE INSTALLED PER FLOOR PLAN TO ACCOMMODATE/MATCH NEW CONSTRUCTION. EXTEND FRAMING AS NECESSARY TO ACCOMMODATE NEW DRYWALL.
M. OWNERS VENDOR RESPONSIBLE FOR DEMOLITION/RELOCATION OF ALL EXISTING SHELVING EXCEPT WHERE NOTED. COORDINATE WITH OWNER PRIOR TO DISPOSAL OF ANY REMAINING SHELVING ITEMS.
N. GENERAL CONTRACTOR TO VERIFY ALL EXISTING CONDITIONS. NOTIFY ARCHITECT OF ANY DISCREPANCIES.

NOTES THIS DRAWING:

1. REMOVE EXISTING WALL PARTITION.
2. REMOVE EXISTING LIMESTONE, CMU, AND ASSOCIATED CONNECTORS. SALVAGE LIMESTONE PANELS, REFER TO FLOOR PLANS FOR NEW LOCATION.
3. EXISTING DOOR TO REMAIN.
4. REMOVE EXISTING DOOR, FRAME, AND ALL ASSOCIATED HARDWARE.
5. REMOVE EXISTING ALUMINUM STOREFRONT AND ALL ASSOCIATED HARDWARE.
6. REMOVE EXISTING CASEWORK/SHELVING.
7. REMOVE EXISTING PLUMBING FIXTURES AND ACCESSORIES. REFER TO PLUMBING DRAWINGS FOR DETAILS.
8. EXISTING GLAZING TO REMAIN.(* LOCATIONS INDICATE GLAZING TO BE REMOVED AS PART OF ALTERNATE #4).
9. REMOVE EXISTING DRYWALL AND FURRING.
10. PORTION OF EXISTING WALL PARTITION TO REMAIN.
11. REMOVE EXISTING CARPET, PAD, ADDITIONAL UNDERLAYMENT, AND ADHESIVE (IF APPLICABLE) FOR NEW FLOORING. REFER TO INTERIOR FINISH PLANS FOR NEW FLOORING MATERIAL AND LOCATION. PREP SLAB FOR NEW FLOORING AS REQUIRED.
12. REMOVE EXISTING VINYL/TILE FLOORING AND UNDERLAYMENT AS NEEDED FOR NEW FLOORING. REFER TO INTERIOR FINISH PLANS FOR NEW FLOORING MATERIAL AND LOCATION. PREP SLAB FOR NEW FLOORING AS REQUIRED.
13. GC TO REMOVE REMAINING TRACK SYSTEM FROM DISMANTLING OF MOVABLE SHELVING BY OWNER'S VENDOR. GC TO REPAIR FLOOR AS NEEDED FOR NEW FLOORING.
14. EXISTING ELECTRICAL PANEL TO REMAIN. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS.
15. GC TO REMOVE AND REPLACE EXISTING LADDER. RE: SPECIFICATIONS FOR DETAIL.
16. GC TO DISMANTLE SOUND BOOTH. COORDINATE WITH OWNER FOR STORAGE DURING CONSTRUCTION. GC SHALL ENSURE ALL PIECES ARE ACCOUNTED FOR, FOR PROPER REASSEMBLY BY OWNER.
17. REMOVE PORTION OF EXISTING MASONRY WALL FOR NEW WINDOW/DOOR. SHORE EXISTING STRUCTURE AS REQUIRED TO INSTALL NEW LINTEL. SEE FLOOR PLAN AND STRUCTURAL DRAWINGS FOR ADDITIONAL INFORMATION.
18. NO WORK IN THIS AREA.
19. REMOVE EXISTING TOILET PARTITION AND HARDWARE.
20. EXISTING UPS TO REMAIN.
21. MOP SINK TO REMAIN.
22. EXISTING CHASE TO REMAIN.
23. REMOVE DRYWALL FROM EXISTING COLUMN, TYPICAL. SEE GENERAL NOTE "L".

B

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SECOND FLOOR DEMOLITION PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

D102

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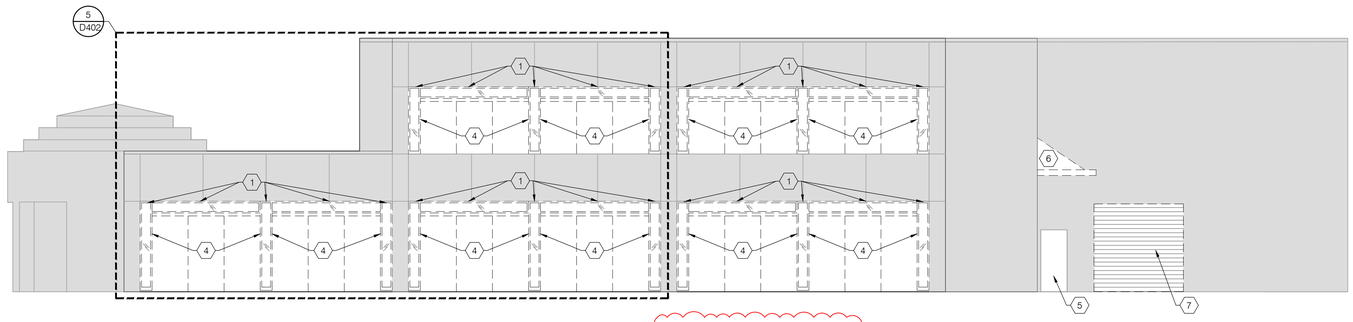
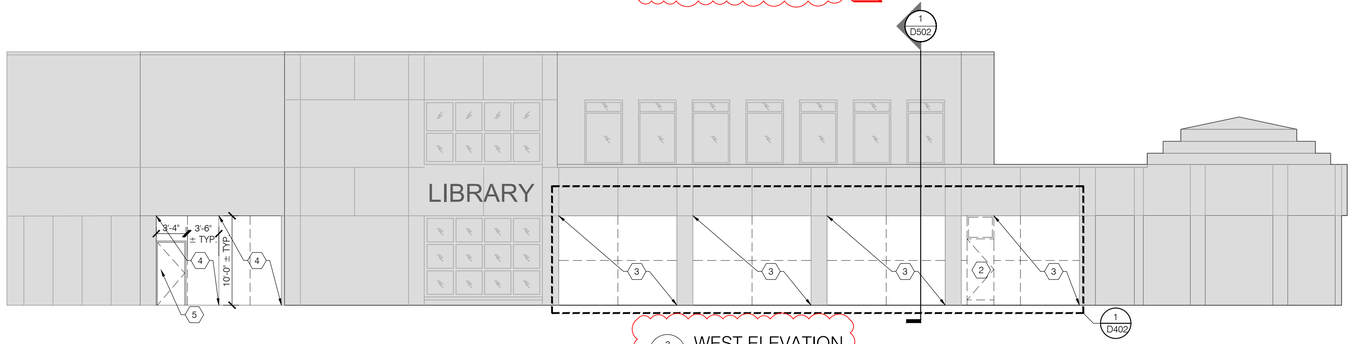


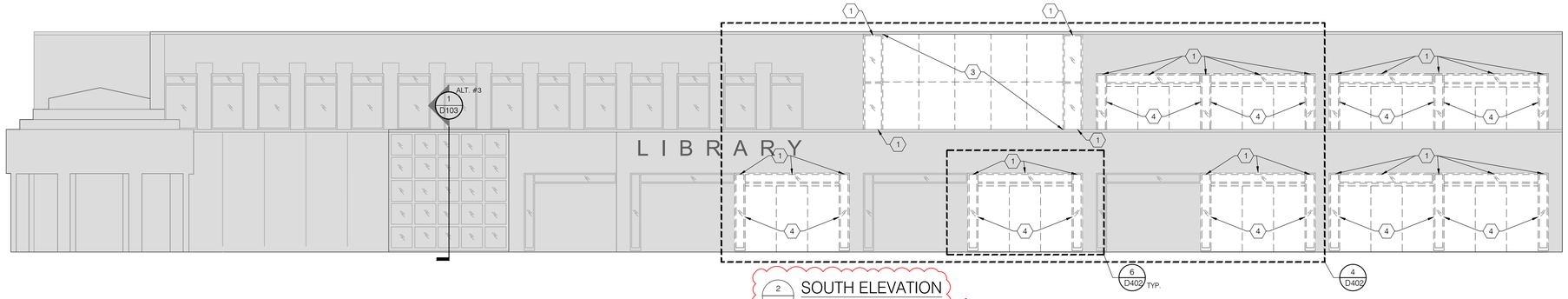
4 D401 EAST ELEVATION
SCALE: 1/8"=1'-0"

B



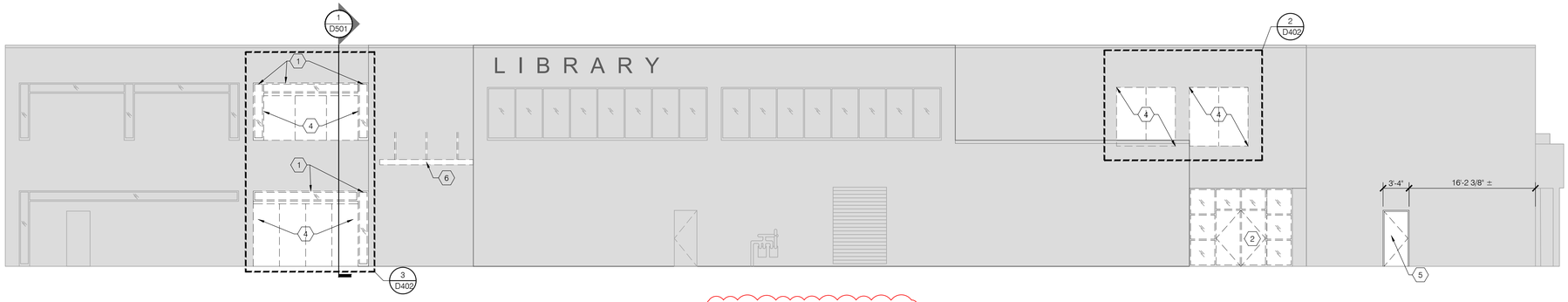
3 D401 WEST ELEVATION
SCALE: 1/8"=1'-0"

B



2 D401 SOUTH ELEVATION
SCALE: 1/8"=1'-0"

B



1 D401 NORTH ELEVATION
SCALE: 1/8"=1'-0"

B

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. REFER TO ELEVATIONS FOR NEW CONFIGURATION.
C. SHADED AREAS INDICATE EXISTING ITEMS TO REMAIN.
D. REFER TO A800 SERIES FOR NEW STOREFRONT TYPES.

NOTES THIS DRAWING:

1. REMOVE EXISTING WINDOW, FRAME, SILL, AND ANCHORING SYSTEM.
2. REMOVE EXISTING DOOR, FRAME, AND HARDWARE.
3. REMOVE EXISTING LIMESTONE PANEL W/ CMU BACKUP.
4. REMOVE EXISTING FLUTED CONCRETE PANEL W/ CMU BACKUP.
5. REMOVE PORTION OF LIMESTONE/CONCRETE PANEL FOR NEW DOOR AND FRAME.
6. REMOVE EXISTING METAL CANOPY AND SUPPORTS.
7. REPLACE GARAGE DOOR. MATCH EXISTING FINISH.

B

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DEMOLITION
EXTERIOR
ELEVATIONS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

D401

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Filename : 21-2113_D401.dwg Plot Date : Jan. 20, 2023 8:15am

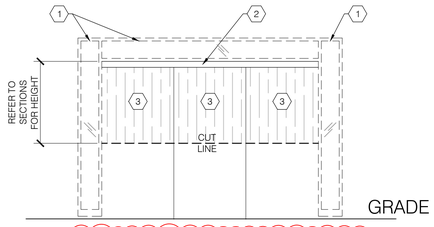
GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. REFER TO ELEVATIONS FOR NEW CONFIGURATION.
C. SHADED AREAS INDICATE EXISTING ITEMS TO REMAIN.
D. REFER TO A800 SERIES FOR NEW STOREFRONT TYPES.

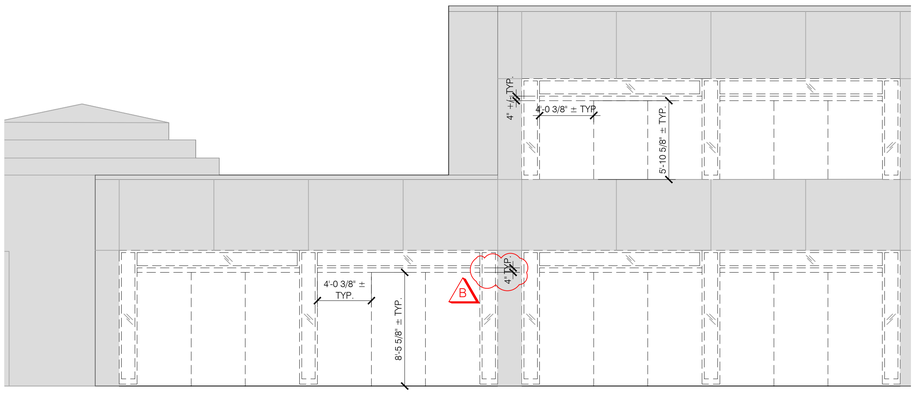
NOTES THIS DRAWING:

1. REMOVE EXISTING WINDOW, FRAME, SILL, AND ANCHORING SYSTEM.
2. MAINTAIN EXISTING LIMESTONE SILL. TO BE USED AS NEW SILL FOR NEW STOREFRONT. REFER TO ELEVATIONS FOR ADDITIONAL DETAIL.
3. FLUTED CONCRETE PANEL.

B



6 D402 EXAMPLE SALVAGE DETAIL
SCALE: 1/4"=1'-0"



5 D402 EAST ELEVATION ENLARGED
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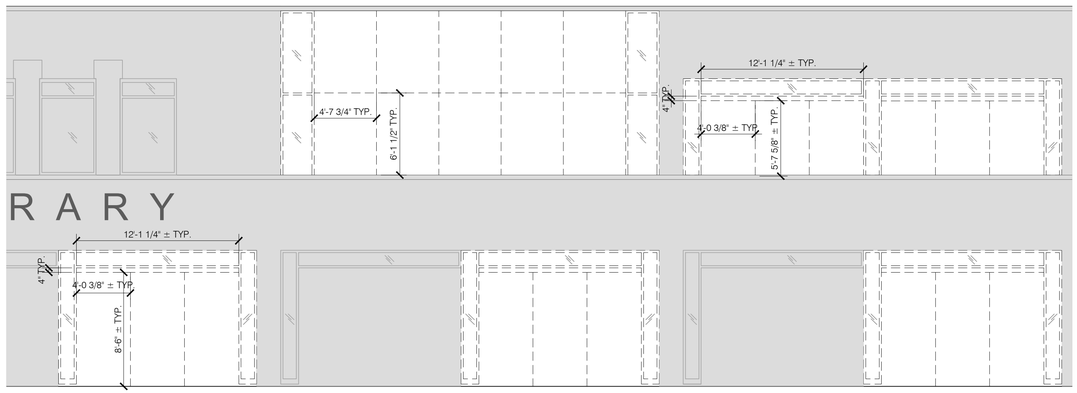
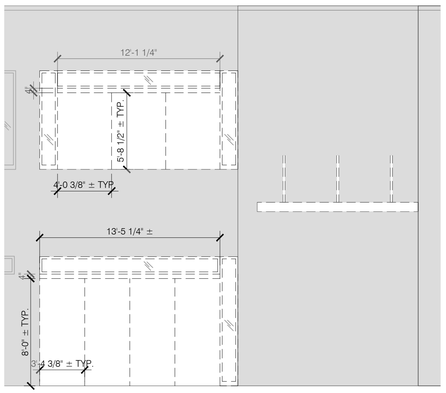


4 D402 SOUTH ELEVATION ENLARGED
SCALE: 3/16"=1'-0"



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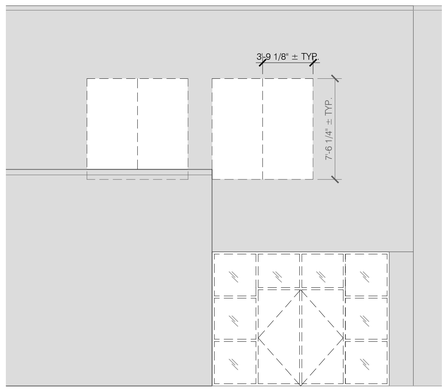

2 D402 NORTH ELEVATION ENLARGED
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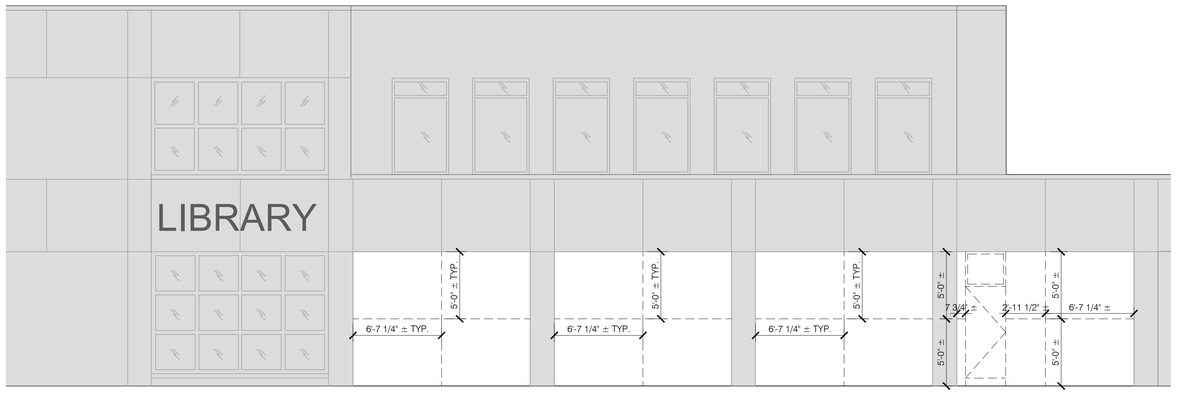

1 D402 WEST ELEVATION ENLARGED
SCALE: 3/16"=1'-0"

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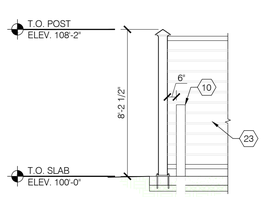
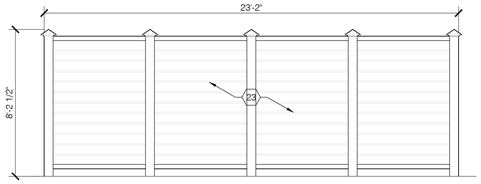
Scale:	AS NOTED
Job No.:	21-2113

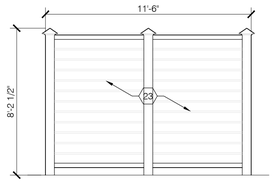
D402



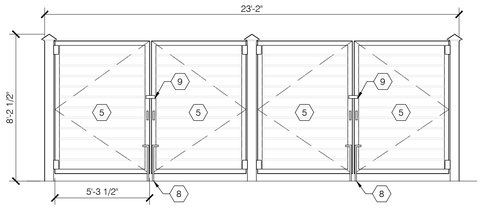
10 / A001 DUMPSTER ENCLOSURE SECTION
SCALE: 1/4" = 1'-0"



9 / A001 DUMPSTER ENCLOSURE REAR ELEVATION
SCALE: 1/4" = 1'-0"



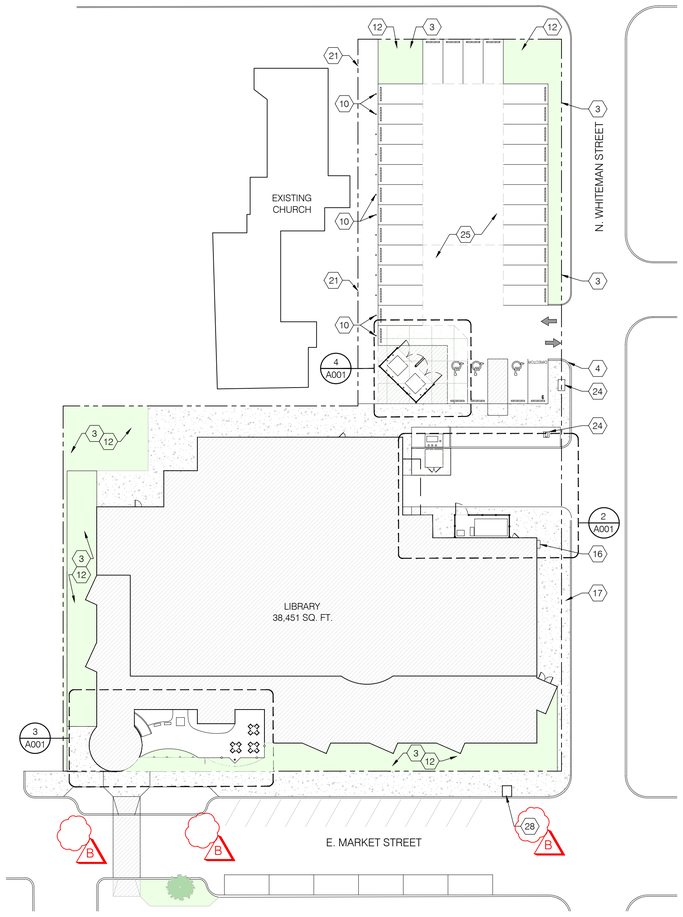
8 / A001 DUMPSTER ENCLOSURE SIDE ELEVATION
SCALE: 1/4" = 1'-0"



7 / A001 DUMPSTER ENCLOSURE FRONT ELEVATION
SCALE: 1/4" = 1'-0"

6 / A001 MECHANICAL ENCLOSURE SIDE ELEVATION
SCALE: 1/4" = 1'-0"

5 / A001 MECHANICAL ENCLOSURE FRONT ELEVATION
SCALE: 1/4" = 1'-0"



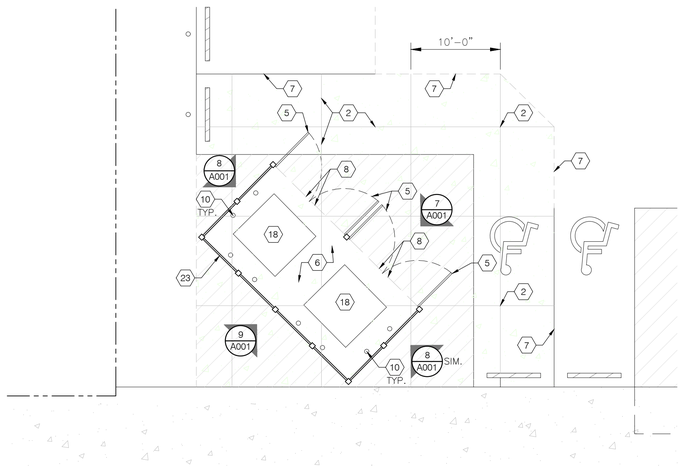
1 / A001 ARCHITECTURAL SITE PLAN
SCALE: 1/32" = 1'-0"

GENERAL NOTES:

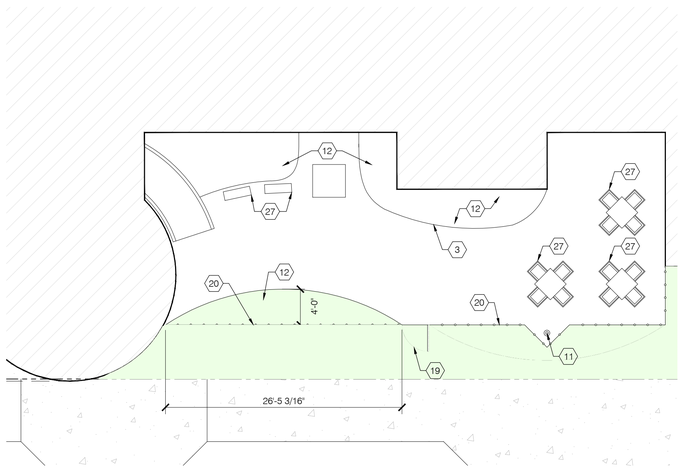
A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. THE ELEVATION OF EXTERIOR LANDINGS AT EXTERIOR DOOR ENTRANCE / EXIT SHALL START AT THE SAME ELEVATION AS FINISH FLOOR. SLOPE AWAY FROM DOORS; SLOPE SHALL BE NO MORE THAN ONE UNIT IN FIFTY OR 2% SLOPE.
C. REFER TO CIVIL DRAWINGS FOR ADDITIONAL INFORMATION.
D. FINAL GRADING TO BE INCLUDED IN BASE BID, NOT A PORTION OF LANDSCAPING/IRRIGATION ALLOWANCE. SEE SPECIFICATIONS.

NOTES THIS DRAWING:

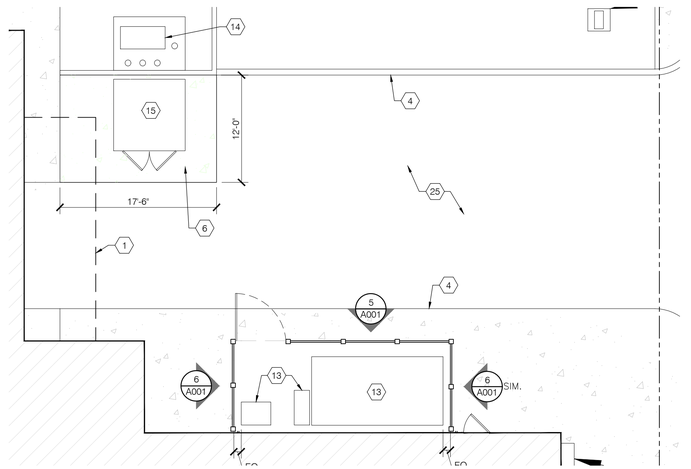
1. OUTLINE OF CANOPY ABOVE.
2. SAWCUT CONTROL JOINTS ARE DIMENSIONED TO APPROXIMATE LOCATIONS. FIELD VERIFY ALIGNMENT WITH AS BUILT BUILDING ELEMENTS AND CONFIRM WITH ARCHITECT PRIOR TO CUTTING CONTROL JOINT.
3. SEED AND STRAW ALL DISTURBED AND NEW GRASS AREAS.
4. CONCRETE CURB. SEE CIVIL DRAWINGS.
5. HEAVY DUTY COMPOSITE DOORS WITH HINGES, FLUSH BOLTS AND GATE LOCK, COLOR TO BE SELECTED BY ARCHITECT. CONCEALED FASTENERS ON PAINTED METAL FRAME.
6. CONCRETE PAD. RE: CIVIL DRAWINGS FOR ADDITIONAL DETAIL.
7. CONCRETE EXPANSION JOINT.
8. CANE LATCHES WITH HEADERS SET IN SLAB.
9. LOCKABLE GATE LATCH TO BE PROVIDED AND INSTALLED BY GC. LOCK TO BE PROVIDED BY OWNER.
10. 6" PIPE BOLLARD, 4'-0" EXPOSED LENGTH, PAINTED, 18" DIA. FOOTING.
11. 25'-0" ALUMINUM FLAGPOLE WITH INTERNAL ROPE W/ CLAM CLEAT INSTALLED PER MANUFACTURER'S SPECIFICATIONS. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
12. LANDSCAPING AREA; REFER TO L001.
13. EXISTING MECHANICAL TO REMAIN.
14. EXISTING TRANSFORMER TO REMAIN.
15. RELOCATED STORAGE SHED.
16. NEW WALK UP BOOK DROP.
17. WIDENED SIDEWALK. RE: CIVIL DRAWINGS FOR ADDITIONAL DETAIL.
18. RELOCATED DUMPSTERS.
19. METAL GATE TO MATCH EXISTING HEIGHT AND FINISH. RE: A801 FOR KEYING INFORMATION.
20. METAL FENCE TO MATCH EXISTING HEIGHT AND FINISH.
21. ASPHALT WALKWAY TO REMAIN.
22. EXISTING BOOK DROP TO REMAIN.
23. MODULAR DUMPSTER ENCLOSURE. RE: SPECIFICATIONS FOR ADDITIONAL DETAILS.
24. EXISTING ELECTRICAL TO REMAIN.
25. ASPHALT DRIVE. RE: CIVIL FOR ADDITIONAL INFORMATION.
26. EXISTING WATER SERVICE HATCH TO REMAIN.
27. RELOCATED PATIO FURNITURE.
28. EXISTING EXTERIOR BOOK-DROP TO REMAIN



4 / A001 ENLARGED DUMPSTER PLAN
SCALE: 1/8" = 1'-0"



3 / A001 ENLARGED PATIO PLAN
SCALE: 1/8" = 1'-0"



2 / A001 ENLARGED PLAN
SCALE: 1/8" = 1'-0"

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ARCHITECTURAL SITE PLAN

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Scale:	AS NOTED
Job No.:	21-2113

A001

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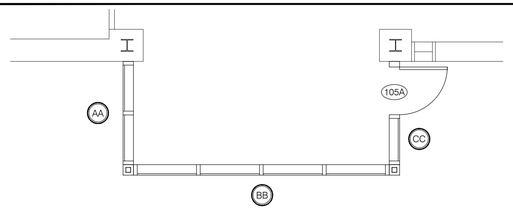

3 / A101 CURTAIN WALL - ALTERNATE #3
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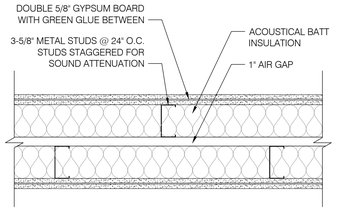


2 / A101 WALL TYPE "C"
SCALE: 1-1/2"=1'-0"

PARTITION LEGEND:

A. 3-5/8" METAL STUDS @ 24" O.C. WITH 5/8" GYPSUM BOARD ON EACH FACE TO 6" ABOVE CEILING SYSTEM. BRACE(KICKERS) WHERE REQUIRED.

B. 3-5/8" METAL STUDS @ 24" O.C. WITH 5/8" GYPSUM BOARD ON EACH FACE. FILL STUD CAVITY WITH ACOUSTICAL BATT INSULATION. EXTEND TO UNDERSIDE OF DECK.

B1. SAME AS "B" EXCEPT HALF WALL. HEIGHT OF FRAMING TO BE 4'-0" A.F.F.

C. DOUBLE 3-5/8" METAL STUDS (24" O.C.) WITH 1" AIR GAP AND ACOUSTICAL INSULATION. EACH FACE IS DOUBLE 5/8" GYPSUM WITH GREEN GLUE IN BETWEEN. STUDS TO BE STAGGERED BETWEEN TWO WALLS TO INCREASE SOUND ATTENUATION. EXTEND TO THE UNDERSIDE OF DECK.

D. 3-5/8" METAL STUDS (24" O.C.) WITH ACOUSTICAL BATT INSULATION. SINGLE 5/8" GYPSUM ON ONE SIDE WITH DOUBLE 5/8" GYPSUM (WITH GREEN GLUE) ON RECEIVING SIDE. EXTEND TO UNDERSIDE OF DECK.

E. PLUMBING CHASE WALL: 5/8" GYPSUM BOARD EACH SIDE ON 6" METAL STUDS AT 24" O.C. EXTEND ENTIRE PARTITION ASSEMBLY TO UNDERSIDE OF TRUSSES. FILL STUD CAVITY WITH ACOUSTICAL BATT INSULATION. TOP OF PARTITION TO BOTTOM STRUCTURE ABOVE WITH SLIP CAP CONNECTION TO ALLOW FOR DEFLECTION.

F. 6" METAL STUDS AT 24" O.C WITH 5/8" GYPSUM BOARD ON EXPOSED FACE. FILL CAVITY WITH R-13 BATT INSULATION. LIMESTONE BLOCKING ON EXTERIOR SIDE. EXTEND TO UNDERSIDE OF DECK.

F1. SAME AS "F" WITHOUT LIMESTONE BLOCKING. FILL CAVITY WITH ACOUSTICAL BATT INSULATION.

G. 8" REINFORCED CMU WALL (INFILL).

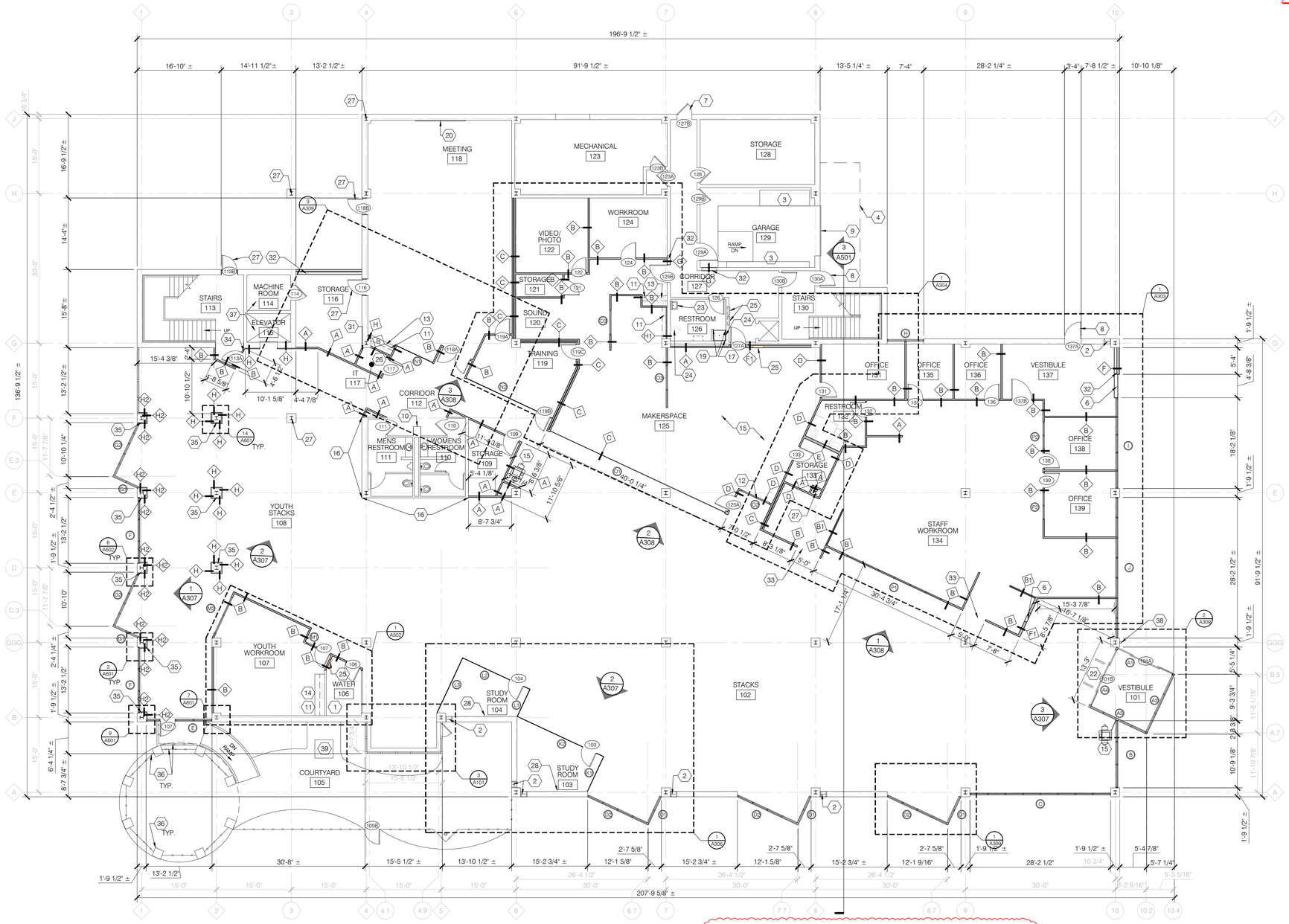
H. 2-1/2" METAL STUDS AT 24" O.C. WITH 5/8" GYPSUM BOARD ON PATRON SIDE. EXTEND 6" ABOVE CEILING SYSTEM.

H1. SAME AS "H" EXCEPT EXTEND TO UNDERSIDE OF DECK.

H2. SAME AS "H" EXCEPT EXTEND TO UNDERSIDE OF DECK. FILL CAVITY WITH R-12.5 BATT INSULATION.

I. CHASE WALL: 5/8" GYPSUM BOARD ON PATRON SIDE OF 3-5/8" METAL STUDS @ 24" O.C. EXTEND ENTIRE PARTITION ASSEMBLY FULL LENGTH OF SHAFT.

J. 2-1/2" METAL STUDS AT 24" O.C. WITH 5/8" GYPSUM BOARD ON PATRON SIDE. EXTEND TO UNDERSIDE OF DECK. FILL CAVITY WITH R-12.5 BATT INSULATION. 6" STRUCTURAL METAL STUDS, TIE IN WITH NEW LIMESTONE PANELS ON EXTERIOR. REFER TO STRUCTURAL DRAWINGS FOR ADDITIONAL DETAILS.



1 / A101 FIRST FLOOR PLAN
SCALE: 3/32"=1'-0"

SCALE: 3/32" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. COORDINATE DOOR AND WINDOW SIZES AND OPENINGS WITH SCHEDULE AND ELEVATIONS ON A800 SERIES DRAWINGS. NOTIFY THE ARCHITECT IN CASE OF ANY DISCREPANCIES. VERIFY WALL OPENING REQUIREMENTS WITH EQUIPMENT SUPPLIER PRIOR TO INSTALLATION.
C. CLEAN ALL SALVAGED LIMESTONE AS A RESULT OF DEMOLITION, MODIFICATION, AND RELOCATION.
D. PROTECT ALL EXISTING ITEMS TO REMAIN THROUGHOUT CONSTRUCTION.
E. ALL DIMENSIONS ARE TO AND FROM FACE OF MASONRY, POURED CONCRETE, OR WOOD/METAL STUDS UNLESS NOTED OTHERWISE.
F. REFER TO STRUCTURAL DRAWINGS FOR STEEL INFORMATION.
G. PROVIDE BLOCKING TO ALL CASEWORK, COUNTERTOPS, EQUIPMENT, AND FIXTURES AS NEEDED. VERIFY BLOCKING LOCATION WITH SUPPLIER PRIOR TO INSTALLATION.
H. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL, WALL FINISHES AND PAINT COLOR.
I. FLOOR TRANSITIONS FOR DIFFERENT MATERIALS OR CHANGES IN FLOOR PATTERN SHALL OCCUR UNDER A DOOR WHEN IT OCCURS IN A DOORWAY.
J. ALIGN FINISH FACE OF WALLS WHEN TWO DIFFERENT PARTITION TYPES INTERSECT TO CREATE A UNIFORM WALL PLANE.
K. VERIFY WALL OPENING REQUIREMENTS WITH EQUIPMENT SUPPLIER PRIOR TO INSTALLATION.
L. ALL RESTROOMS TO RECEIVE MOISTURE RESISTANT GYPSUM BOARD.
M. COORDINATE INSTALLATION OF ALL OWNER SUPPLIED ITEMS WITH OWNER PRIOR TO INSTALLATION.
N. CONTRACTOR TO PERFORM MOISTURE CONTENT TEST ON EXISTING EXTERIOR CMU WALLS PRIOR TO PAINTING OR INSTALLING GYPSUM BOARD ON NEW FURRING.

NOTES THIS DRAWING:

1. EXISTING WATER SERVICE. RE: PLUMBING DRAWINGS.
2. EXISTING STOREFRONT/GLAZING TO REMAIN.
3. EXISTING ELECTRICAL SERVICE. RE: ELECTRICAL DRAWINGS.
4. OUTLINE OF CANOPY ABOVE. RE: ELEVATIONS FOR ADDITIONAL DETAIL.
5. COMPUTER BY OWNER. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
6. THRU-WALL BOOK DROP PROVIDED BY OWNER, INSTALLED BY G.C. VERIFY SIZE AND LOCATION WITH EQUIPMENT SUPPLIER. INSTALL PER MANUFACTURERS DETAILS. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION. SEE DETAIL 4/A505.
7. EXISTING HOLLOW METAL DOOR TO REMAIN.
8. NEW HOLLOW METAL DOOR AND FRAME IN EXISTING OPENING. PAINT TO MATCH EXISTING. RE: A801 FOR ADDITIONAL INFORMATION.
9. NEW OVERHEAD GARAGE DOOR TO MATCH EXISTING SIZE, AND COLOR. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
10. EXISTING DRINKING FOUNTAIN TO REMAIN.
11. CASEWORK (COUNTER TOPS, BASE CABINETS, WALL CABINETS) PROVIDED AND INSTALLED BY GENERAL CONTRACTOR. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
12. REFRIGERATOR PROVIDED BY OWNER, INSTALLED BY GENERAL CONTRACTOR. RE: PLUMBING DRAWINGS FOR ADDITIONAL INFORMATION.
13. SINGLE-BOWL SINK IN COUNTERTOP. RE: PLUMBING DRAWINGS.
14. DOUBLE-BOWL SINK IN COUNTERTOP. RE: PLUMBING DRAWINGS.
15. COPIER PROVIDED BY OWNER. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
16. PROVIDE LEVEL 5 FINISH ON THIS WALL. GRAPHIC WALLS BY OWNER. NO EQUIPMENT, SWITCHES, OUTLETS, OR OTHER DEVICES SHALL BE LOCATED ON THIS WALL UNLESS COORDINATED WITH ARCHITECT.
17. EXISTING MOP SINK. RECAULK ALL EDGES OF MOP SINK USING WATERPROOF CAULK AS NEEDED. RE: PLUMBING DRAWINGS.
18. NEW MOP SINK. CAULK ALL EDGES OF MOP SINK USING WATERPROOF CAULK AS NEEDED. RE: PLUMBING DRAWINGS.
19. MECHANICALLY FASTEN FRP PANEL FROM TOP EDGE OF EXISTING MOP SINK TO 4'-0" A.F.F. PANEL SHALL BE 4'-0" WIDE IN BOTH DIRECTIONS BEHIND THE MOP SINK. CAULK JOINT BETWEEN TOP EDGE OF MOP SINK AND BOTTOM EDGE OF EDGE OF FRP PANEL USING WATERPROOF CAULK.
20. CEILING MOUNTED PROJECTOR SCREEN PROVIDED BY OWNER, INSTALLED BY G.C.
21. SEMI-RECESSED FIRE EXTINGUISHER CABINET WITH A 10 LB MULTIPURPOSE DRY CHEMICAL FIRE EXTINGUISHER UL-RATED 4-A:60-B-C. FINAL LOCATION PER FIRE INSPECTORS RECOMMENDATIONS. B
22. RFID PROVIDED BY OWNER, INSTALLED BY G.C. VERIFY LOCATION WITH EQUIPMENT SUPPLIER & ELECTRICIAN. INSTALL PER MANUFACTURERS DETAILS. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
23. EXISTING FIXTURE. RE: PLUMBING DRAWINGS.
24. NEW FIXTURE. RE: PLUMBING DRAWINGS. B
25. ELECTRICAL PANEL. RE: ELECTRICAL DRAWINGS.
26. SERVER RACK. RE: ELECTRICAL DRAWINGS.
27. NEW HOLLOW METAL DOOR AND FRAME IN NEW OPENING. PAINT TO MATCH EXISTING. RE: A801 FOR ADDITIONAL INFORMATION. B
28. T.V. BY OWNER. PROVIDE CONTINUOUS 2X12 BLOCKING BETWEEN METAL STUDS FROM 72" TO 96" A.F.F. TOE NAIL OR STRAP BLOCKING TO STUDS IN ADDITION TO END NAILING. COORDINATE WITH ELECTRICAL DRAWINGS.
29. PROVIDE FRAMED OPENING IN WALL, CENTERED ON RACEWAY, IN WALL ABOVE CEILING 7" HIGH X 14" WIDE FOR RACEWAY. SEE DETAIL 3 ON A101. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
30. EXISTING SERVER ROOM. NOT IN SCOPE.
31. 8'-0" TALL FRT PLYWOOD ATTACHED VERTICALLY WITH TOP EDGE AT 8'-6" TO COVER ENTIRE WALL. PAINT TO MATCH ADJACENT WALL COLOR. RE: ELECTRICAL DRAWINGS.
32. FINISHED FACE OF NEW WALL TO ALIGN WITH FINISHED FACE OF EXISTING WALL. PATCH TO MATCH EXISTING.
33. BULKHEAD ABOVE. RE: RCP.
34. WALL MOUNTED TACTILE/BRAILLE EXIT SIGNAGE. PROVIDE ACCESSIBLE SIGNAGE PER ADA GUIDELINES.
35. EXISTING LIMESTONE COLUMN TO REMAIN.
36. SURFACE MOUNTED GUARDRAIL TO MATCH EXISTING SIZE AND FINISH.
37. ELEVATOR (115) AND MACHINE ROOM (114) TO BE UPDATED. SEE SPECIFICATION SECTION 142410 FOR SCOPE OF WORK: MODERNIZATION OF HYDRAULIC ELEVATOR. B
38. RELOCATED KNOX BOX. FINAL LOCATION TO BE DETERMINED BY FIRE INSPECTOR.
39. EXISTING WATER SERVICE HATCH TO REMAIN. REFER TO A/001 FOR ADDITIONAL DETAIL.

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NO.	DESCRIPTION	DATE
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B	ADDENDUM B	01/20/23

PRELIMINARY BID NOT FOR CONSTRUCTION

FIRST FLOOR PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A101

PARTITION LEGEND:

A. 3-5/8" METAL STUDS @ 24" O.C. WITH 5/8" GYPSUM BOARD ON EACH FACE TO 6" ABOVE CEILING SYSTEM. BRACE(KICKERS) WHERE REQUIRED.

B. 3-5/8" METAL STUDS @ 24" O.C. WITH 5/8" GYPSUM BOARD ON EACH FACE. FILL STUD CAVITY WITH ACOUSTICAL BATT INSULATION. EXTEND TO UNDERSIDE OF DECK.

B1. SAME AS "B" EXCEPT HALF WALL. HEIGHT OF FRAMING TO BE 4'-0" A.F.F.

C. DOUBLE 3-5/8" METAL STUDS (24" O.C.) WITH 1" AIR GAP AND ACOUSTICAL INSULATION. EACH FACE IS DOUBLE 5/8" GYPSUM WITH GREEN GLUE IN BETWEEN. STUDS TO BE STAGGERED BETWEEN TWO WALLS TO INCREASE SOUND ATTENUATION. EXTEND TO THE UNDERSIDE OF DECK.

D. 3-5/8" METAL STUDS (24" O.C.) WITH ACOUSTICAL BATT INSULATION. SINGLE 5/8" GYPSUM ON ONE SIDE WITH DOUBLE 5/8" GYPSUM (WITH GREEN GLUE) ON RECEIVING SIDE. EXTEND TO UNDERSIDE OF DECK.

E. PLUMBING CHASE WALL. 5/8" GYPSUM BOARD EACH SIDE ON 6" METAL STUDS AT 24" O.C. EXTEND ENTIRE PARTITION ASSEMBLY TO UNDERSIDE OF TRUSSES. FILL STUD CAVITY WITH ACOUSTICAL BATT INSULATION. TOP OF PARTITION TO BOTTOM STRUCTURE ABOVE WITH SLIP CAP CONNECTION TO ALLOW FOR DEFLECTION.

F. 6" METAL STUDS AT 24" O.C WITH 5/8" GYPSUM BOARD ON EXPOSED FACE. FILL CAVITY WITH R-13 BATT INSULATION. LIMESTONE BLOCKING ON EXTERIOR SIDE. EXTEND TO UNDERSIDE OF DECK.

F1. SAME AS "F" WITHOUT LIMESTONE BLOCKING. FILL CAVITY WITH ACOUSTICAL BATT INSULATION.

G. 8" REINFORCED CMU WALL (INFILL).

H. 2-1/2" METAL STUDS AT 24" O.C. WITH 5/8" GYPSUM BOARD ON PATRON SIDE. EXTEND 6" ABOVE CEILING SYSTEM.

H1. SAME AS "H" EXCEPT EXTEND TO UNDERSIDE OF DECK.

H2. SAME AS "H" EXCEPT EXTEND TO UNDERSIDE OF DECK. FILL CAVITY WITH R-12.5 BATT INSULATION.

I. CHASE WALL: 5/8" GYPSUM BOARD ON PATRON SIDE OF 3-5/8" METAL STUDS @ 24" O.C. EXTEND ENTIRE PARTITION ASSEMBLY FULL LENGTH OF SHAFT.

J. 2-1/2" METAL STUDS AT 24" O.C. WITH 5/8" GYPSUM BOARD ON PATRON SIDE. EXTEND TO UNDERSIDE OF DECK. FILL CAVITY WITH R-12.5 BATT INSULATION. 6" STRUCTURAL METAL STUDS, TIE IN WITH NEW LIMESTONE PANELS ON EXTERIOR. REFER TO STRUCTURAL DRAWINGS FOR ADDITIONAL DETAILS.

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. COORDINATE DOOR AND WINDOW SIZES AND OPENINGS WITH SCHEDULE AND ELEVATIONS ON A800 SERIES DRAWINGS. NOTIFY THE ARCHITECT IN CASE OF ANY DISCREPANCIES. VERIFY WALL OPENING REQUIREMENTS WITH EQUIPMENT SUPPLIER PRIOR TO INSTALLATION.
C. CLEAN ALL SALVAGED LIMESTONE AS A RESULT OF DEMOLITION, MODIFICATION, AND RELOCATION.
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E. ALL DIMENSIONS ARE TO AND FROM FACE OF MASONRY, POURED CONCRETE, OR WOOD/METAL STUDS UNLESS NOTED OTHERWISE.
F. REFER TO STRUCTURAL DRAWINGS FOR STEEL INFORMATION.
G. PROVIDE BLOCKING TO ALL CASEWORK, COUNTERTOPS, EQUIPMENT, AND FIXTURES AS NEEDED. VERIFY BLOCKING LOCATION WITH SUPPLIER PRIOR TO INSTALLATION.
H. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL, WALL FINISHES AND PAINT COLOR.
I. FLOOR TRANSITIONS FOR DIFFERENT MATERIALS OR CHANGES IN FLOOR PATTERN SHALL OCCUR UNDER A DOOR WHEN IT OCCURS IN A DOORWAY.
J. ALIGN FINISH FACE OF WALLS WHEN TWO DIFFERENT PARTITION TYPES INTERSECT TO CREATE A UNIFORM WALL PLANE.
K. VERIFY WALL OPENING REQUIREMENTS WITH EQUIPMENT SUPPLIER PRIOR TO INSTALLATION.
L. ALL RESTROOMS TO RECEIVE MOISTURE RESISTANT GYPSUM BOARD.
M. COORDINATE INSTALLATION OF ALL OWNER SUPPLIED ITEMS WITH OWNER PRIOR TO INSTALLATION.
N. CONTRACTOR TO PERFORM MOISTURE CONTENT TEST ON EXISTING EXTERIOR CMU WALLS PRIOR TO PAINTING OR INSTALLING GYPSUM BOARD ON NEW FURRING.

NOTES THIS DRAWING:

1. EXISTING WATER SERVICE. RE: PLUMBING DRAWINGS.
2. EXISTING STOREFRONT/GLAZING TO REMAIN.
3. EXISTING ELECTRICAL SERVICE. RE: ELECTRICAL DRAWINGS.
4. OUTLINE OF CANOPY ABOVE. RE: ELEVATIONS FOR ADDITIONAL DETAIL.
5. COMPUTER BY OWNER. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
6. THRU-WALL BOOK DROP PROVIDED BY OWNER, INSTALLED BY G.C. VERIFY SIZE AND LOCATION WITH EQUIPMENT SUPPLIER. INSTALL PER MANUFACTURERS DETAILS. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION. SEE DETAIL 4/A505.
7. EXISTING HOLLOW METAL DOOR TO REMAIN.
8. NEW HOLLOW METAL DOOR AND FRAME IN EXISTING OPENING. PAINT TO MATCH EXISTING. RE: A801 FOR ADDITIONAL INFORMATION.
9. NEW OVERHEAD GARAGE DOOR TO MATCH EXISTING SIZE, AND COLOR. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
10. EXISTING DRINKING FOUNTAIN TO REMAIN.
11. CASEWORK (COUNTER TOPS, BASE CABINETS, WALL CABINETS) PROVIDED AND INSTALLED BY GENERAL CONTRACTOR. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.
12. REFRIGERATOR PROVIDED BY OWNER, INSTALLED BY GENERAL CONTRACTOR. RE: PLUMBING DRAWINGS FOR ADDITIONAL INFORMATION.
13. SINGLE-BOWL SINK IN COUNTERTOP. RE: PLUMBING DRAWINGS.
14. DOUBLE-BOWL SINK IN COUNTERTOP. RE: PLUMBING DRAWINGS.
15. COPIER PROVIDED BY OWNER. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
16. PROVIDE LEVEL 5 FINISH ON THIS WALL. GRAPHIC WALLS BY OWNER. NO EQUIPMENT, SWITCHES, OUTLETS, OR OTHER DEVICES SHALL BE LOCATED ON THIS WALL UNLESS COORDINATED WITH ARCHITECT.
17. EXISTING MOP SINK. RECAULK ALL EDGES OF MOP SINK USING WATERPROOF CAULK AS NEEDED. RE: PLUMBING DRAWINGS.
18. NEW MOP SINK. CAULK ALL EDGES OF MOP SINK USING WATERPROOF CAULK AS NEEDED. RE: PLUMBING DRAWINGS.
19. MECHANICALLY FASTEN FRP PANEL FROM TOP EDGE OF EXISTING MOP SINK TO 4'-0" A.F.F. PANEL SHALL BE 4'-0" WIDE IN BOTH DIRECTIONS BEHIND THE MOP SINK. CAULK JOINT BETWEEN TOP EDGE OF MOP SINK AND BOTTOM EDGE OF EDGE OF FRP PANEL USING WATERPROOF CAULK.
20. CEILING MOUNTED PROJECTOR SCREEN PROVIDED BY OWNER, INSTALLED BY G.C.
21. SEMI-RECESSED FIRE EXTINGUISHER CABINET WITH A 10 LB MULTIPURPOSE, DRY CHEMICAL FIRE EXTINGUISHER UL-RATED 4-A:4:60-B-C. FINAL LOCATION PER FIRE INSPECTOR'S RECOMMENDATIONS.
22. RFID PROVIDED BY OWNER, INSTALLED BY G.C. VERIFY LOCATION WITH EQUIPMENT SUPPLIER & ELECTRICIAN. INSTALL PER MANUFACTURERS DETAILS. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
23. EXISTING FIXTURE. RE: PLUMBING DRAWINGS.
24. NEW FIXTURE. RE: PLUMBING DRAWINGS.
25. ELECTRICAL PANEL. RE: ELECTRICAL DRAWINGS.
26. SERVER RACK. RE: ELECTRICAL DRAWINGS.
27. NEW HOLLOW METAL DOOR AND FRAME IN NEW OPENING. PAINT TO MATCH EXISTING. RE: A801 FOR ADDITIONAL INFORMATION.
28. T.V. BY OWNER. PROVIDE CONTINUOUS 2X12 BLOCKING BETWEEN METAL STUDS FROM 72" TO 96" A.F.F. TOE NAIL OR STRAP BLOCKING TO STUDS IN ADDITION TO END NAILING. COORDINATE WITH ELECTRICAL DRAWINGS.
29. PROVIDE FRAMED OPENING IN WALL, CENTERED ON RACEWAY, IN WALL ABOVE CEILING 7" HIGH X 14" WIDE FOR RACEWAY. SEE DETAIL 3 ON A101. RE: ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
30. EXISTING SERVER ROOM. NOT IN SCOPE.
31. 8'-0" TALL FRT PLYWOOD ATTACHED VERTICALLY WITH TOP EDGE AT 8'-6" TO COVER ENTIRE WALL. PAINT TO MATCH ADJACENT WALL COLOR. RE: ELECTRICAL DRAWINGS.
32. FINISHED FACE OF NEW WALL TO ALIGN WITH FINISHED FACE OF EXISTING WALL. PATCH TO MATCH EXISTING.
33. BULKHEAD ABOVE. RE: RCP.
34. WALL MOUNTED TACTILE/BRAILLE EXIT SIGNAGE. PROVIDE ACCESSIBLE SIGNAGE PER ADA GUIDELINES.
35. EXISTING LIMESTONE COLUMN TO REMAIN.
36. SURFACE MOUNTED GUARDRAIL TO MATCH EXISTING SIZE AND FINISH.
37. ELEVATOR (115) AND MACHINE ROOM (114) TO BE UPDATED. SEE SPECIFICATION SECTION 142410 FOR SCOPE OF WORK: MODERNIZATION OF HYDRAULIC ELEVATOR.
38. RELOCATED KNOW BOX. FINAL LOCATION TO BE DETERMINED BY FIRE INSPECTOR.
39. EXISTING WATER SERVICE HATCH TO REMAIN. REFER TO A/001 FOR ADDITIONAL DETAIL.

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B	ADDENDUM B	01/20/23

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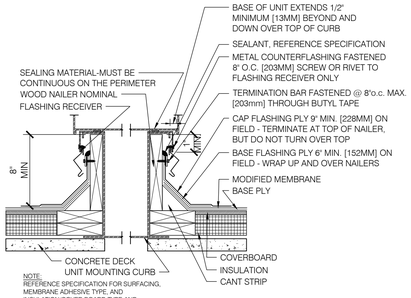
SECOND FLOOR PLAN

Drawn By: BBJ, TW
Scale: AS NOTED
Job No.: 21-2113

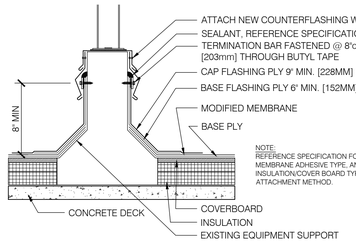
A102

1 A102 SECOND FLOOR PLAN
SCALE: 3/32" = 1'-0"

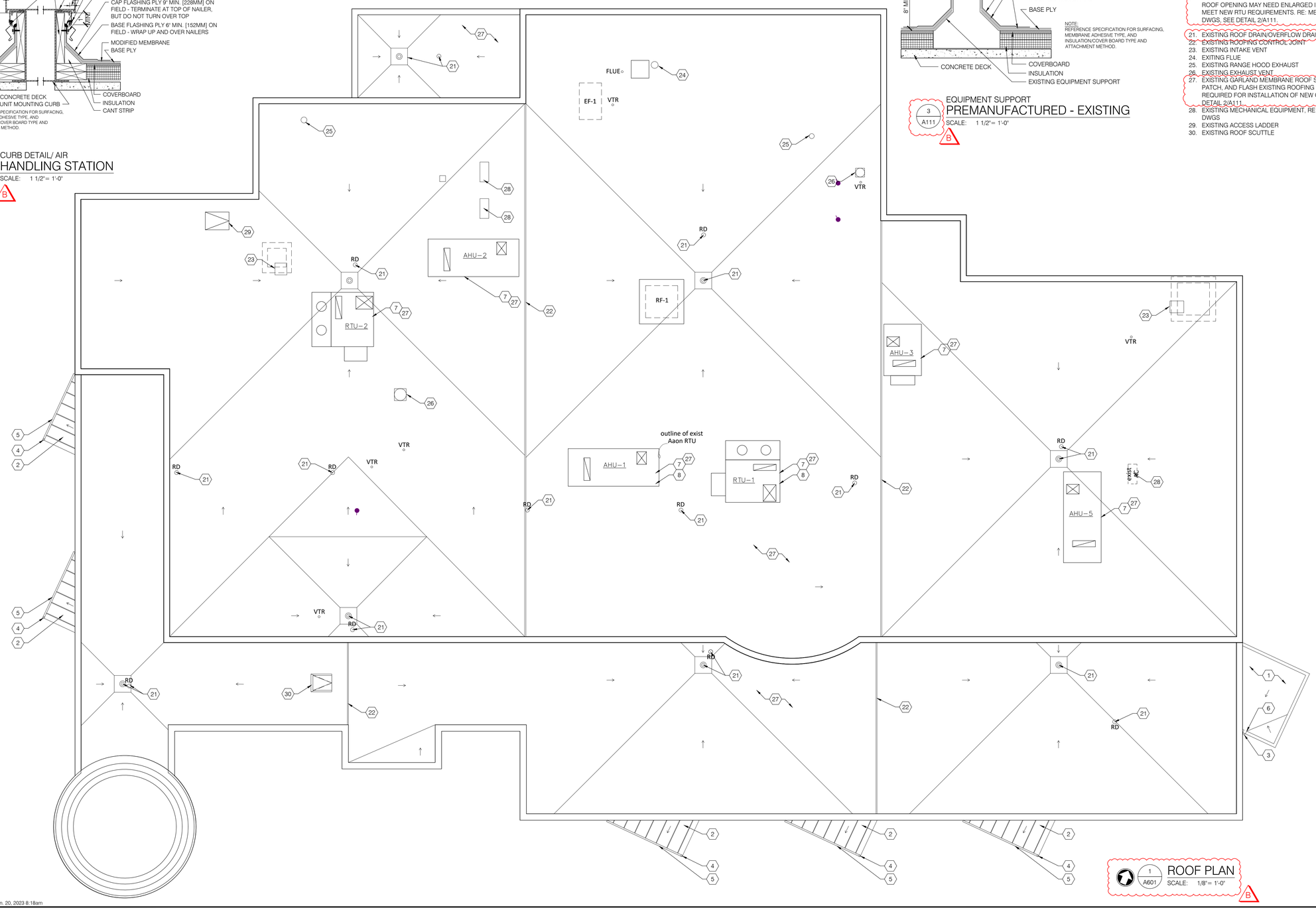
SCALE: 3/32" = 1'-0"



2 / A111 CURB DETAIL/ AIR HANDLING STATION
SCALE: 1 1/2"= 1'-0"



3 / A111 EQUIPMENT SUPPORT PREMANUFACTURED - EXISTING
SCALE: 1 1/2"= 1'-0"



GENERAL NOTES:

A. MODIFY AND REPLACE EXISTING ROOF SYSTEM AS REQUIRED FOR INSTALLATION OF NEW RTU
B. ROOF DETAILS PROVIDED FOR REFERENCE. NOT ALL DETAILS MAY BE USED.

NOTES THIS DRAWING:

1. NEW MEMBRANE ROOF
2. NEW STANDING SEAM ROOF
3. PRE-FINISHED 3"x4" DOWNSPOUT TO GRADE
4. PRE-FINISHED 3"x3" DOWNSPOUT TO GRADE
5. 3" PRE-FINISHED ALUMINUM GUTTER
6. 4"x6" WIDE PRE-FINISHED ALUMINUM SCUPPER WITH COLLECTOR BOX
7. NEW RTU, RE: MECHANICAL DWGS FOR DETAILS
8. MODIFY EXISTING CURB AS REQUIRED FOR NEW RTU ROOF OPENING MAY NEED ENLARGED IN ORDER TO MEET NEW RTU REQUIREMENTS. RE: MECHANICAL DWGS, SEE DETAIL 2/A111. B
21. EXISTING ROOF DRAIN/OVERFLOW DRAIN B
22. EXISTING ROOFING CONTROL JOINT
23. EXISTING INTAKE VENT
24. EXITING FLUE
25. EXISTING RANGE HOOD EXHAUST
26. EXISTING EXHAUST VENT
27. EXISTING GARLAND MEMBRANE ROOF SYSTEM. CUT, PATCH, AND FLASH EXISTING ROOFING SYSTEM AS REQUIRED FOR INSTALLATION OF NEW CURB, SEE DETAIL 2/A111. B
28. EXISTING MECHANICAL EQUIPMENT, RE: MECHANICAL DWGS
29. EXISTING ACCESS LADDER
30. EXISTING ROOF SCUTTLE

1 / A601 ROOF PLAN
SCALE: 1/8"= 1'-0" B

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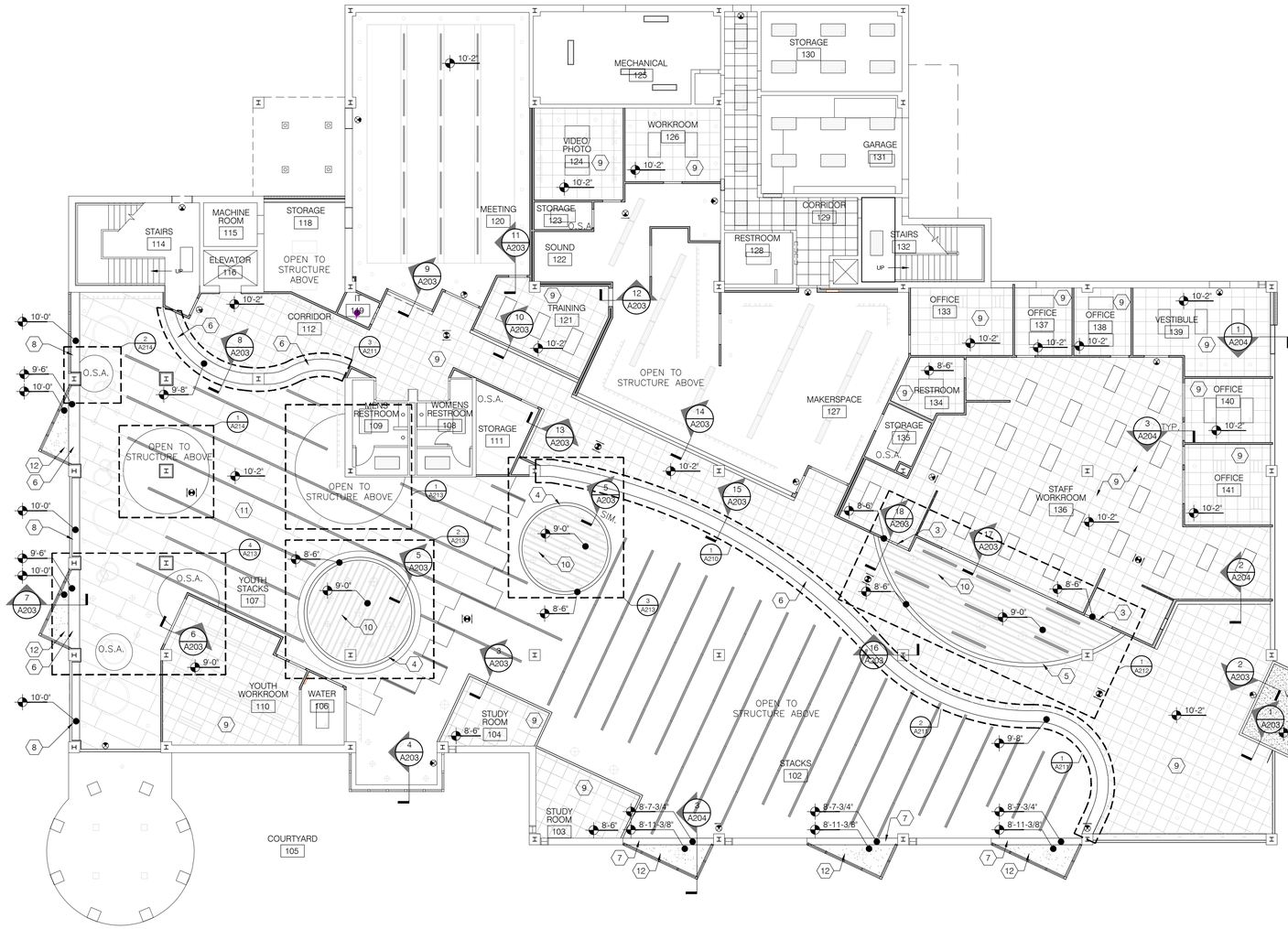
ROOF PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A111



FIRST FLOOR
REFLECTED CEILING PLAN
SCALE: 3/32"=1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. ALL DIMENSIONS ARE TO AND FROM FACE OF MASONRY, POURED CONCRETE, OR METAL STUDS UNLESS NOTED OTHERWISE.
C. REFER TO STRUCTURAL DRAWINGS FOR STEEL, BAR JOIST AND FRAMING INFORMATION.
D. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL AND WALL FINISHES.
E. ALIGN FINISH FACE OF WALLS AND BULKHEADS WHEN TWO DIFFERENT PARTITION TYPES INTERSECT TO CREATE A UNIFORM WALL PLANE.
F. PAINT MUST CURE 7 DAYS PRIOR TO INSTALLATION OF GRAPHICS. GENERAL CONTRACTOR IS RESPONSIBLE FOR COORDINATING GRAPHIC INSTALL AND PAINT IN THEIR CONSTRUCTION SCHEDULE.
G. LIGHTING AND HVAC SHOWN FOR REFERENCE. REFER TO MECHANICAL AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.

NOTES THIS DRAWING:

1. NO CEILING IN THIS AREA.
2. ALIGN FINISH FACE.
3. 3-5/8" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
4. 6" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
5. 9-3/4" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
6. 1'-9 1/2" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
7. 1'-1" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
8. 1'-3" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
9. ACOUSTIC CEILING, RE: SPECIFICATIONS FOR DETAILS.
10. BLADE CEILING "BARZ" SYSTEM, RE: SPECIFICATIONS FOR DETAILS.
11. WOOD CEILING "RULON" SYSTEM, RE: SPECIFICATIONS FOR DETAILS.
12. GYPSUM BOARD CEILING, RE: SPECIFICATIONS FOR DETAILS.
13. BOTTOM OF FIXTURE AT 8'-6" A.F.F.
14. BOTTOM OF FIXTURE AT 7'-9" A.F.F.
15. BOTTOM OF FIXTURE AT 8'-5" A.F.F.
16. FRY REGLET DRM-25-25 DA.1 DRYWALL REVEAL MOLDING AT INTERSECTION OF INTERIOR WALL PARTITION AND BULKHEAD. PAINT TO MATCH ADJACENT BULKHEAD. REFER TO INTERIORS FINISH PLANS.

CEILING LEGEND:

- 24" x 48" RECESSED DIRECT / INDIRECT FIXTURE
- 24" x 24" RECESSED DIRECT / INDIRECT FIXTURE
- RECESSED CAN LIGHT
- DIRECT / INDIRECT FIXTURE
- 12" x 48" RECESSED FIXTURE
- PENDANT FIXTURE
- 2x2 SUSPENDED ACOUSTICAL CEILING
- GYPSUM BOARD CEILING
- SUPPLY DIFFUSER
- RETURN GRILLE
- EXHAUST FAN
- EXIT SIGN

B

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XENIA COMMUNITY LIBRARY

76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS			
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

PRELIMINARY BID
NOT FOR
CONSTRUCTION

FIRST FLOOR
REFLECTED
CEILING PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A201

File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_A201.dwg Plot Date : Jan. 20, 2023 8:20am

SECOND FLOOR
REFLECTED CEILING PLAN
SCALE: 3/32" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. ALL DIMENSIONS ARE TO AND FROM FACE OF MASONRY, POURED CONCRETE, OR METAL STUDS UNLESS NOTED OTHERWISE.
C. REFER TO STRUCTURAL DRAWINGS FOR STEEL, BAR JOIST AND FRAMING INFORMATION.
D. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL AND WALL FINISHES.
E. ALIGN FINISH FACE OF WALLS AND BULKHEADS WHEN TWO DIFFERENT PARTITION TYPES INTERSECT TO CREATE A UNIFORM WALL PLANE.
F. PAINT MUST CURE 7 DAYS PRIOR TO INSTALLATION OF GRAPHICS. GENERAL CONTRACTOR IS RESPONSIBLE FOR COORDINATING GRAPHIC INSTALL AND PAINT IN THEIR CONSTRUCTION SCHEDULE.
G. LIGHTING AND HVAC SHOWN FOR REFERENCE. REFER TO MECHANICAL AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.

NOTES THIS DRAWING:

1. NO CEILING IN THIS AREA.
2. ALIGN FINISH FACE.
3. 3-5/8" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
4. 6" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
5. 9-3/4" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
6. 1'-9 1/2" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
7. 1'-1" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
8. 1'-3" GYPSUM BOARD BULKHEAD. HEIGHT AS NOTED.
9. ACOUSTIC CEILING, RE: SPECIFICATIONS FOR DETAILS.
10. BLADE CEILING "BARZ" SYSTEM, RE: SPECIFICATIONS FOR DETAILS.
11. WOOD CEILING "RULON" SYSTEM, RE: SPECIFICATIONS FOR DETAILS.
12. GYPSUM BOARD CEILING, RE: SPECIFICATIONS FOR DETAILS.
13. BOTTOM OF FIXTURE AT 8'-6" A.F.F.
14. BOTTOM OF FIXTURE AT 7'-9" A.F.F.
15. BOTTOM OF FIXTURE AT 8'-5" A.F.F.
16. FRY REGLET DRM-25-25 DA.1 DRYWALL REVEAL MOLDING AT INTERSECTION OF INTERIOR WALL PARTITION AND BULKHEAD. PAINT TO MATCH ADJACENT BULKHEAD. REFER TO INTERIORS FINISH PLANS.

CEILING LEGEND:

- 24" x 48" RECESSED DIRECT / INDIRECT FIXTURE
- 24" x 24" RECESSED DIRECT / INDIRECT FIXTURE
- RECESSED CAN LIGHT
- DIRECT / INDIRECT FIXTURE
- 12" x 48" RECESSED FIXTURE
- PENDANT FIXTURE
- 2x2 SUSPENDED ACOUSTICAL CEILING
- GYPSUM BOARD CEILING
- SUPPLY DIFFUSER
- RETURN GRILLE
- EXHAUST FAN
- EXIT SIGN

B

K4 ARCHITECTURE + DESIGN
555 Gest Street
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Fax: (513) 455-5008
Webpage: www.k4architecture.com
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COMPLETE RENOVATION/MECHANICAL UPGRADES:

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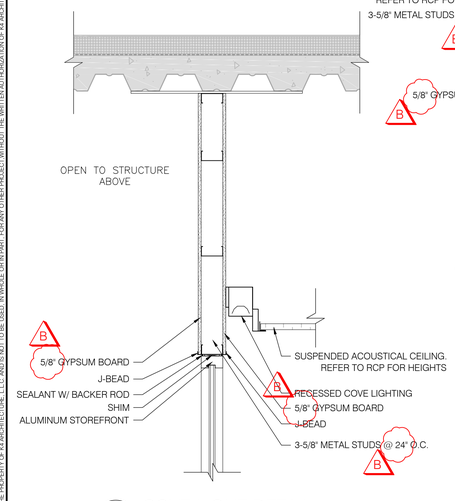
PRELIMINARY BID
NOT FOR
CONSTRUCTION

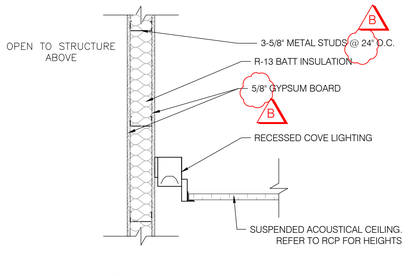
SECOND FLOOR
REFLECTED
CEILING PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

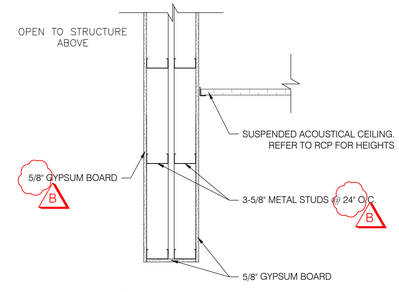
A202



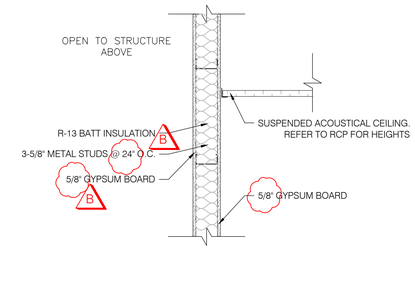
14 A203 COVE LIGHT DETAIL
SCALE: 1"=1'-0"



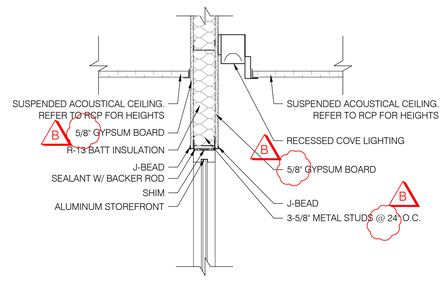
13 A203 COVE LIGHT DETAIL
SCALE: 1"=1'-0"



12 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"

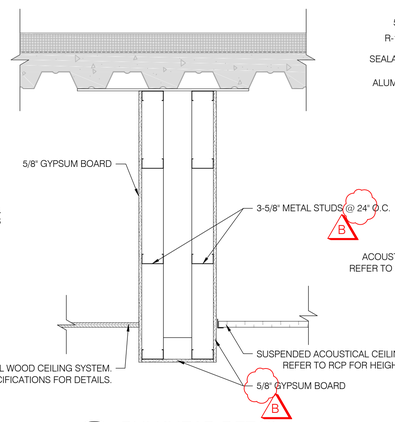


11 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"

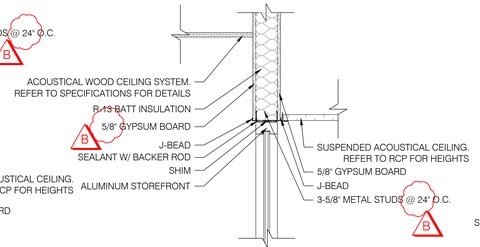


10 A203 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"

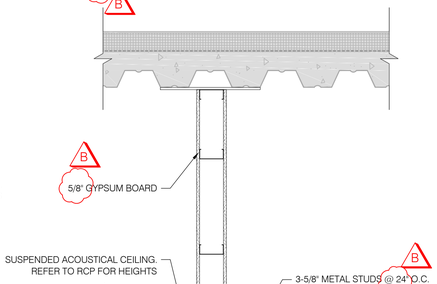
9 A203 CAN LIGHT BULKHEAD DETAIL
SCALE: 1"=1'-0"



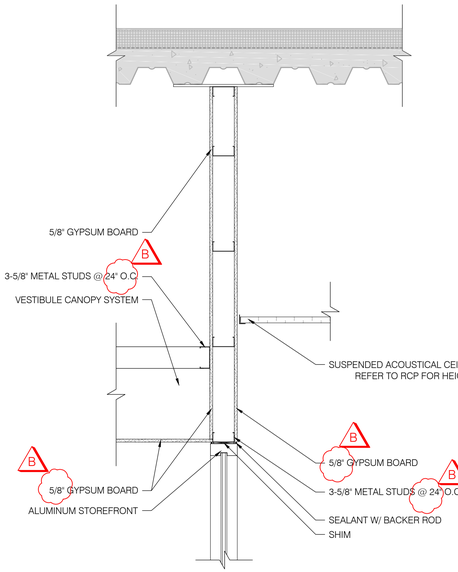
8 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"



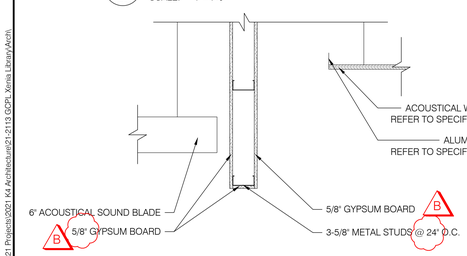
6 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"



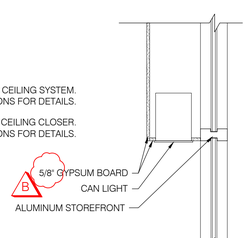
2 A203 VESTIBULE BULKHEAD DETAIL
SCALE: 1"=1'-0"



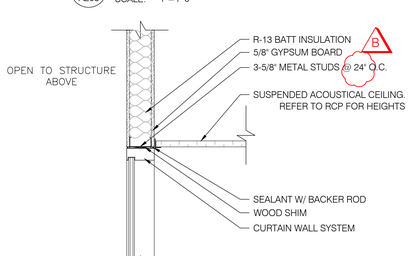
1 A203 VESTIBULE BULKHEAD DETAIL
SCALE: 1"=1'-0"



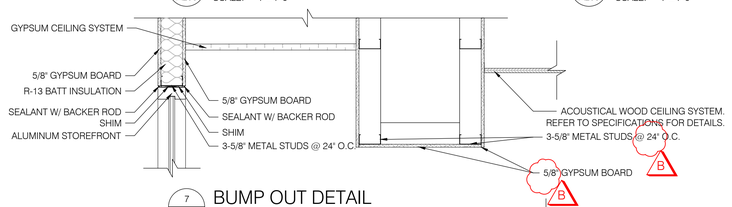
5 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"



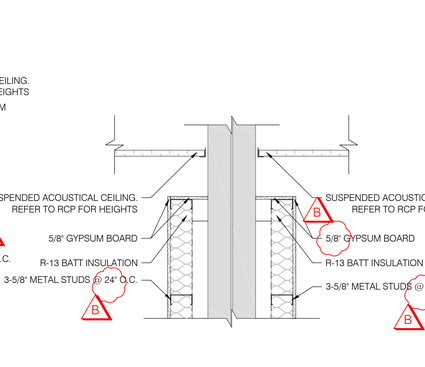
4 A203 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"



3 A203 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"

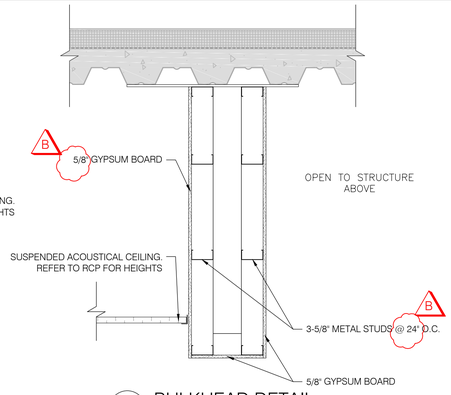


7 A203 BUMP OUT DETAIL
SCALE: 1"=1'-0"



18 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"

17 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"



16 A203 COLUMN DETAIL
SCALE: 1"=1'-0"

15 A203 BULKHEAD DETAIL
SCALE: 1"=1'-0"

ARCHITECTURE + DESIGN
555 Gest Street
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COMPLETE RENOVATION/MECHANICAL UPGRADES:

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REVISIONS / SUBMISSIONS

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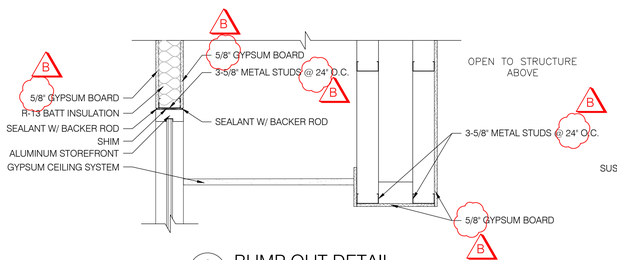
FIRST FLOOR CEILING SECTIONS & DETAILS

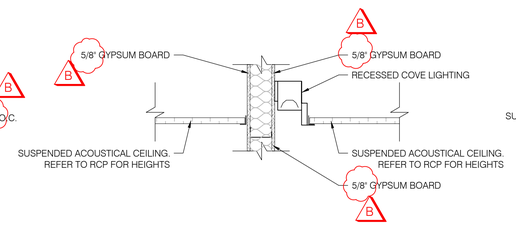
Drawn By: BBJ, TW
Scale: AS NOTED
Job No.: 21-2113

A203

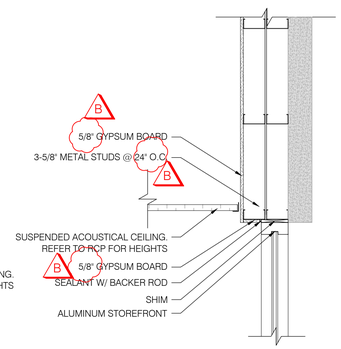
File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_A201.dwg Plot Date : Jan. 19, 2023 8:34am



3 A204 BUMP OUT DETAIL
SCALE: 1"=1'-0"



2 A204 COVE LIGHT DETAIL
SCALE: 1"=1'-0"



1 A204 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"

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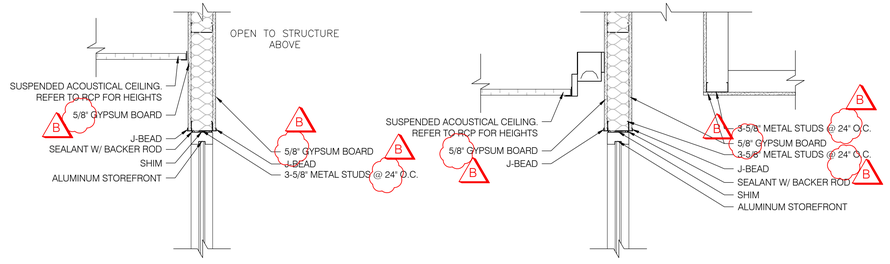
PRELIMINARY BID NOT FOR CONSTRUCTION

FIRST FLOOR CEILING SECTIONS & DETAILS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

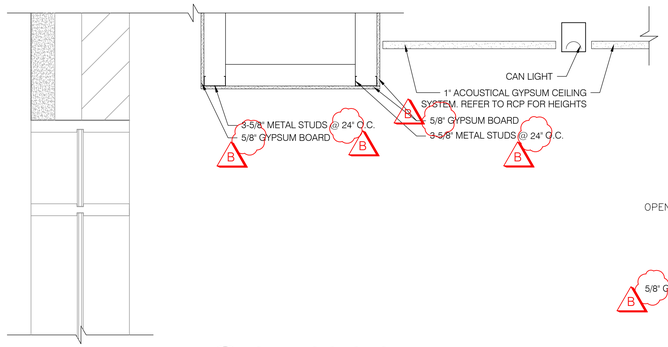
A204

File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_A201.dwg Plot Date : Jan. 20, 2023 8:19am

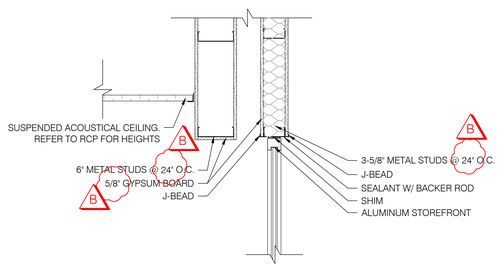


4 A205 BULKHEAD DETAIL
SCALE: 1"=1'-0"

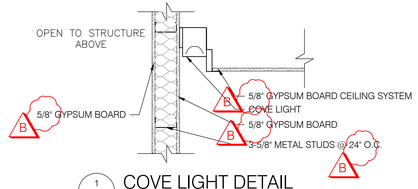
3 A205 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"



2 A205 CEILING SECTION DETAIL
SCALE: 1"=1'-0"



5 A205 WINDOW BULKHEAD DETAIL
SCALE: 1"=1'-0"



1 A205 COVE LIGHT DETAIL
SCALE: 1"=1'-0"

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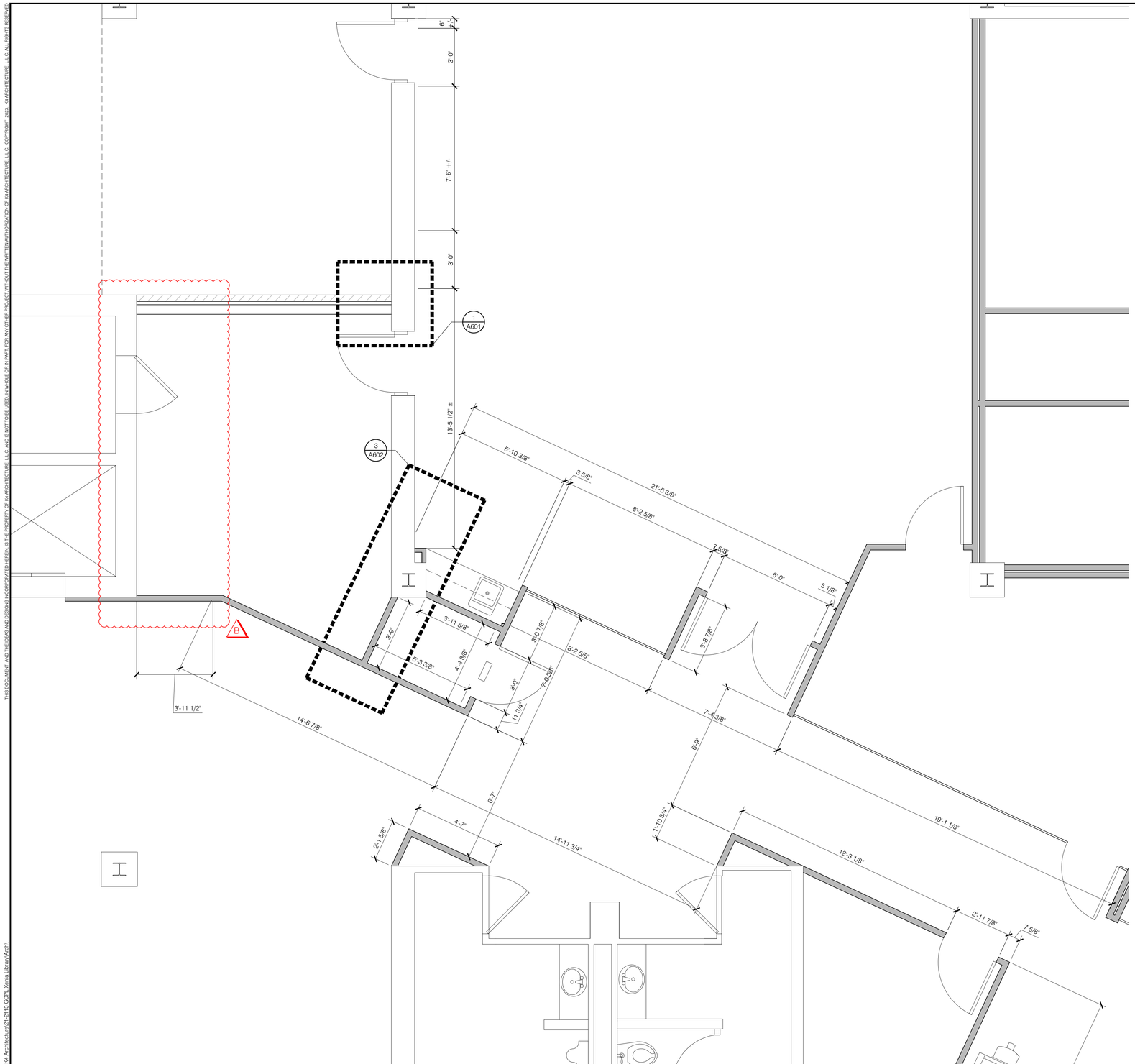
SECOND FLOOR
CEILING SECTIONS
& DETAILS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A205

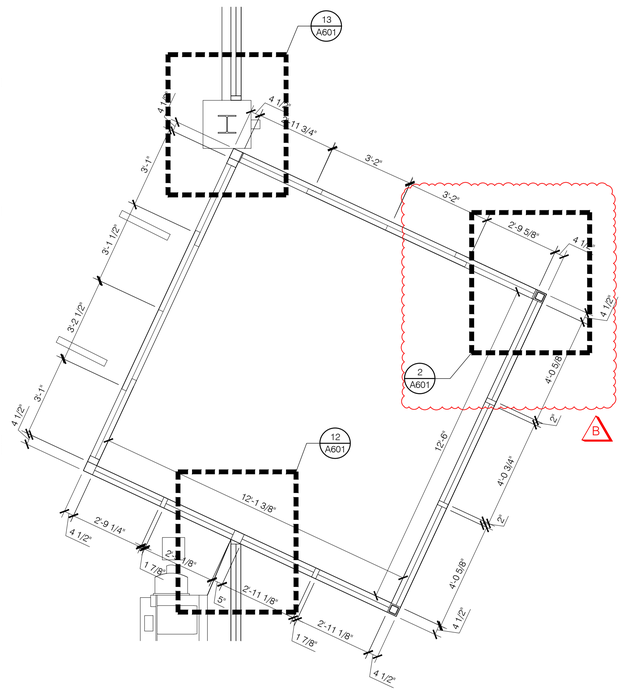


CORRIDOR 112
ENLARGED PLAN
SCALE: 3/8" = 1'-0"

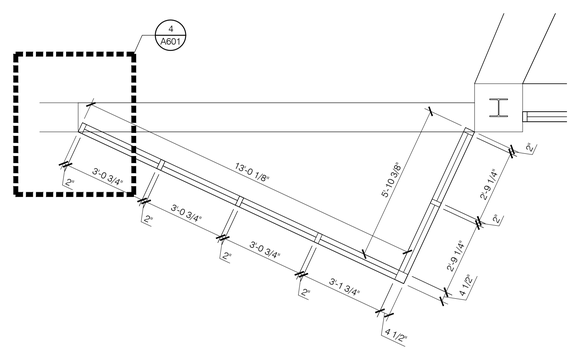
GENERAL NOTES:

A. REFER TO T001 FOR MORE GENERAL NOTES.
B. ALL DIMENSIONS ARE TO FACE OF MASONRY, POURED CONCRETE, OR METAL STUDS.
C. ALL INTERIOR PARTITIONS ARE 3-5/8" METAL STUDS AT 24"O.C. WITH 5/8" GYPSUM BOARD EACH SIDE, UNLESS NOTED OTHERWISE.
D. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL, WALL FINISHES AND PAINT COLOR.
E. COORDINATE DOOR SIZES AND OPENING WITH SCHEDULE ON SHEET A801. NOTIFY ARCHITECT INCASE OF ANY DISCREPANCIES.
F. PROVIDE 2X BLOCKING @ ALL WALL HUNG CASEWORK, FIXTURES, AND SHELVES.

B



VESTIBULE 101
ENLARGED PLAN
SCALE: 3/8" = 1'-0"



STACKS 102
ENLARGED PLAN
SCALE: 3/8" = 1'-0"

ARCHITECTURE
+ DESIGN
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CONSTRUCTION

FIRST FLOOR
ENLARGED PLANS,
ELEVATIONS, &
DETAILS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

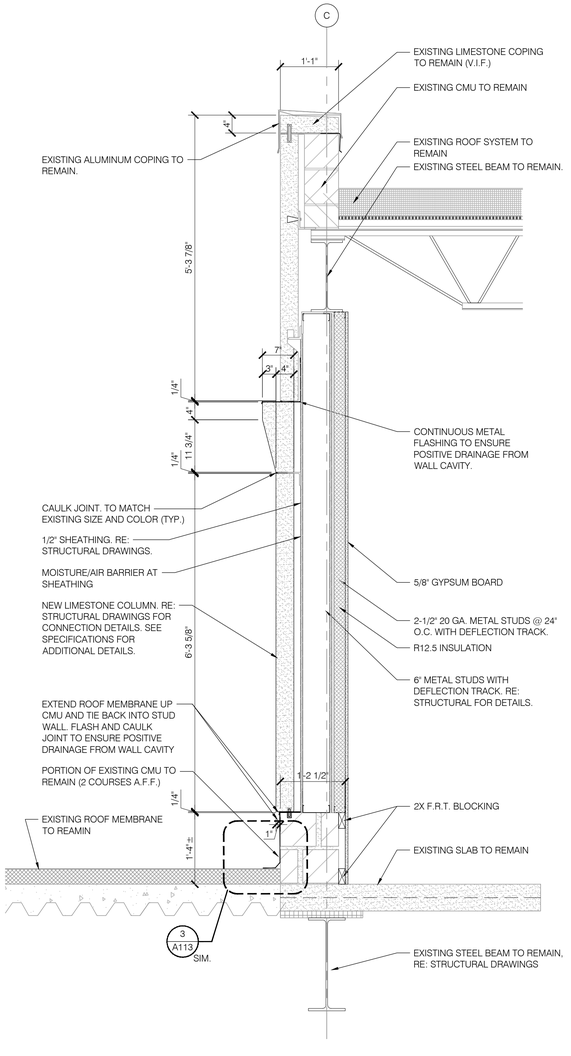
A309

File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch

Filename : 21-2113_A301.dwg Plot Date : Jan. 20, 2023 8:25am

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION.
C. REFER TO A113 FOR ROOF DETAILS.
D. REFER TO A114 FOR STANDING SEAM ROOF DETAILS.
E. NEW FIREPROOFING OVER EXPOSED STEEL AS REQUIRED BY CODE. MATCH AND PATCH TO EXISTING



1 / A506 2ND FLR COLUMN SECTION
SCALE: 1/2" = 1'-0"

ARCHITECTURE + DESIGN
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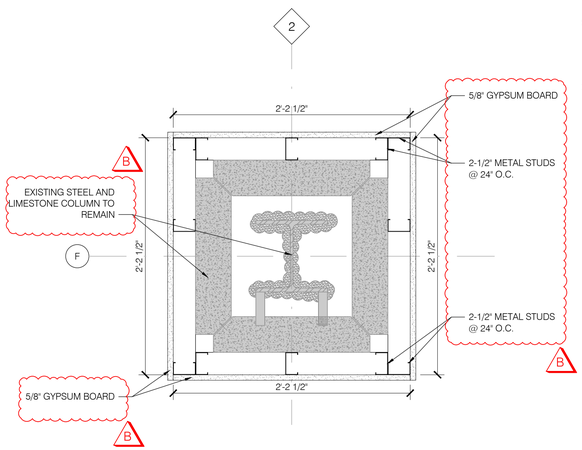
PRELIMINARY BID NOT FOR CONSTRUCTION

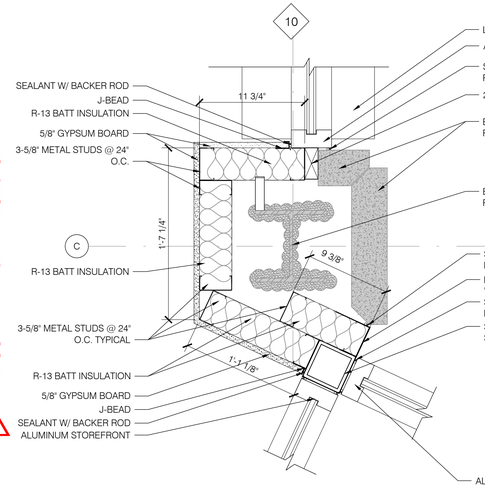
WALL SECTIONS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

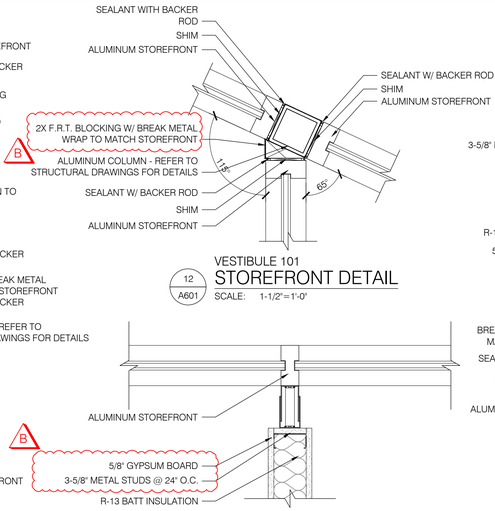
A506



YOUTH STACKS 108
COLUMN DETAIL
14 / A601 SCALE: 1-1/2"=1'-0"



VESTIBULE 101
COLUMN DETAIL
13 / A601 SCALE: 1-1/2"=1'-0"

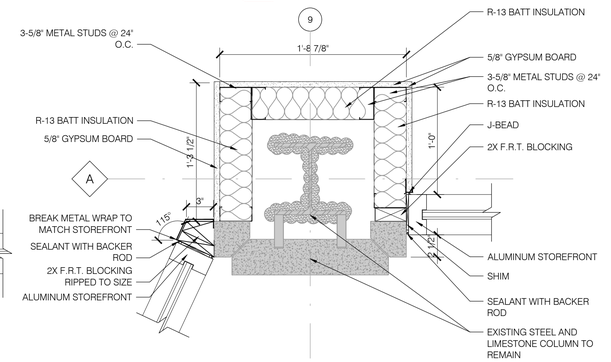


VESTIBULE 101
STOREFRONT DETAIL
12 / A601 SCALE: 1-1/2"=1'-0"

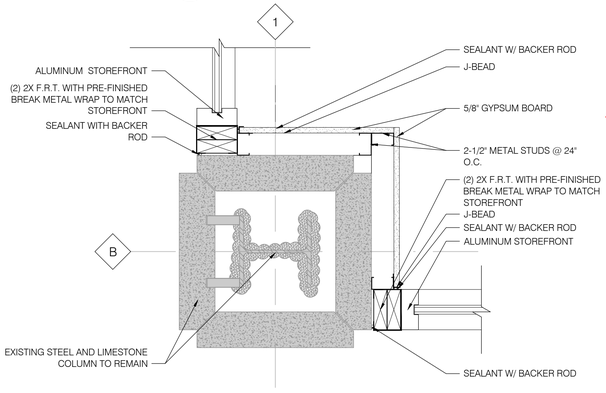
OFFICE 135
PARTITION MULLION DETAIL
11 / A601 SCALE: 1-1/2"=1'-0"

GENERAL NOTES:

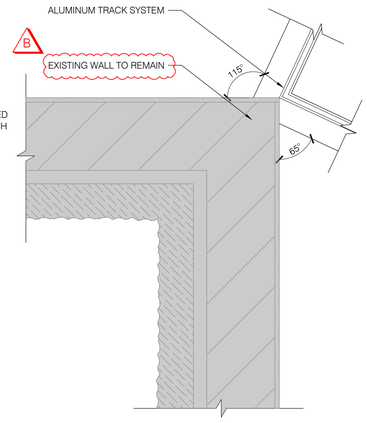
A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. ALL WOOD BLOCKING TO BE FIRE TREATED.
C. ANY EXISTING SPRAY ON FIREPROOFING ON STRUCTURAL STEEL DISTURBED, FOR NEW CONSTRUCTION, MUST BE PATCHED.



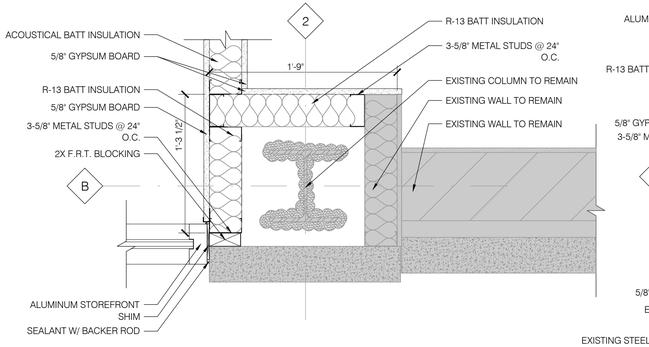
STACKS 102
COLUMN DETAIL
10 / A601 SCALE: 1-1/2"=1'-0"



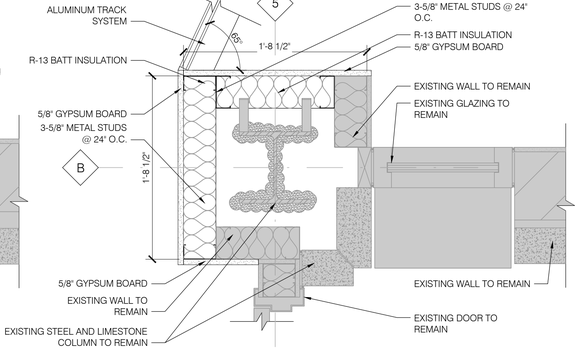
YOUTH STACKS 108
COLUMN DETAIL
9 / A601 SCALE: 1-1/2"=1'-0"



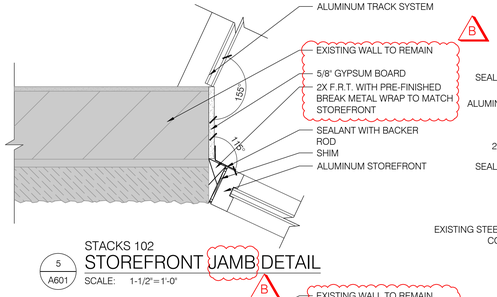
STUDY ROOM 103
STOREFRONT DETAIL
8 / A601 SCALE: 1-1/2"=1'-0"



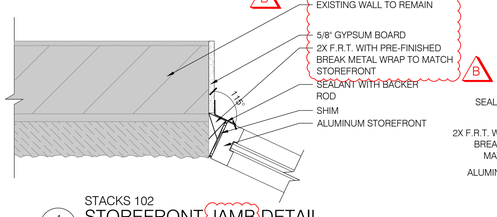
YOUTH STACKS 108
STOREFRONT JAMB DETAIL
7 / A601 SCALE: 1-1/2"=1'-0"



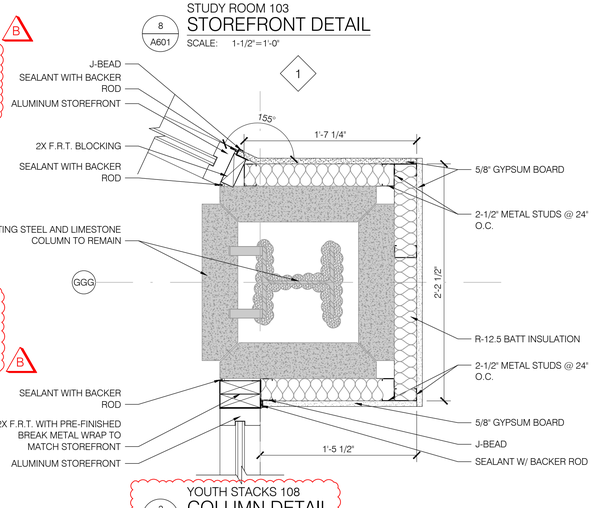
STUDY ROOM 104
STOREFRONT DETAIL
6 / A601 SCALE: 1-1/2"=1'-0"



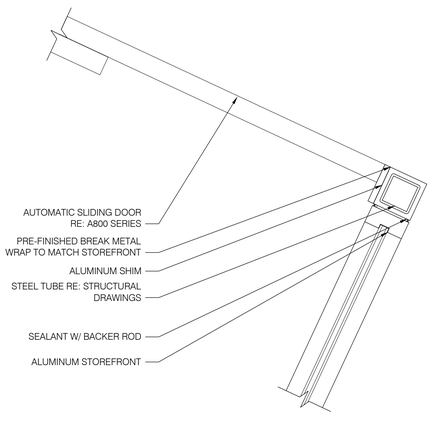
STACKS 102
STOREFRONT JAMB DETAIL
5 / A601 SCALE: 1-1/2"=1'-0"



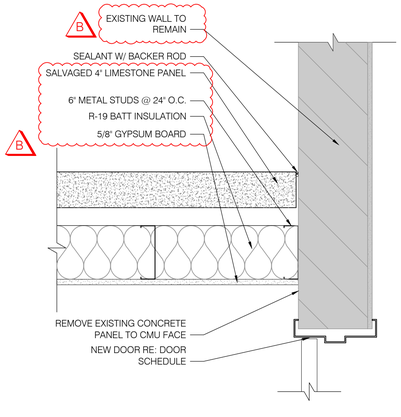
STACKS 102
STOREFRONT JAMB DETAIL
4 / A601 SCALE: 1-1/2"=1'-0"



YOUTH STACKS 108
COLUMN DETAIL
3 / A601 SCALE: 1-1/2"=1'-0"



VESTIBULE 101
COLUMN DETAIL
2 / A601 SCALE: 1-1/2"=1'-0"



STORAGE 116
STOREFRONT DETAIL
1 / A601 SCALE: 1-1/2"=1'-0"

ARCHITECTURE + DESIGN
555 Gest Street
Cincinnati, Ohio 45203
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COMPLETE RENOVATION/MECHANICAL UPGRADES:

Greene County Public Library

XENIA COMMUNITY LIBRARY
76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS		
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

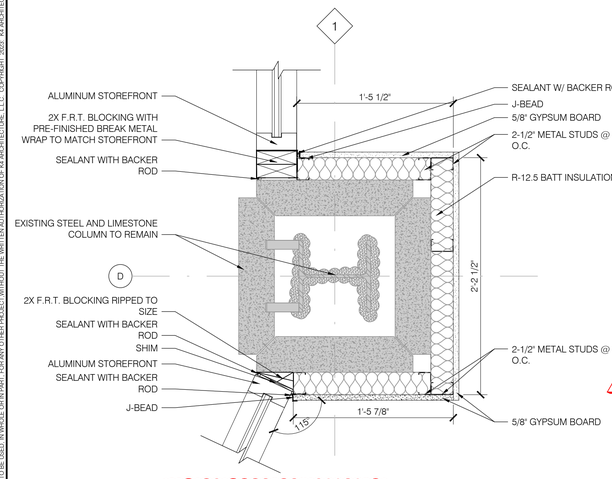
PRELIMINARY BID NOT FOR CONSTRUCTION

FIRST FLOOR PLAN DETAILS

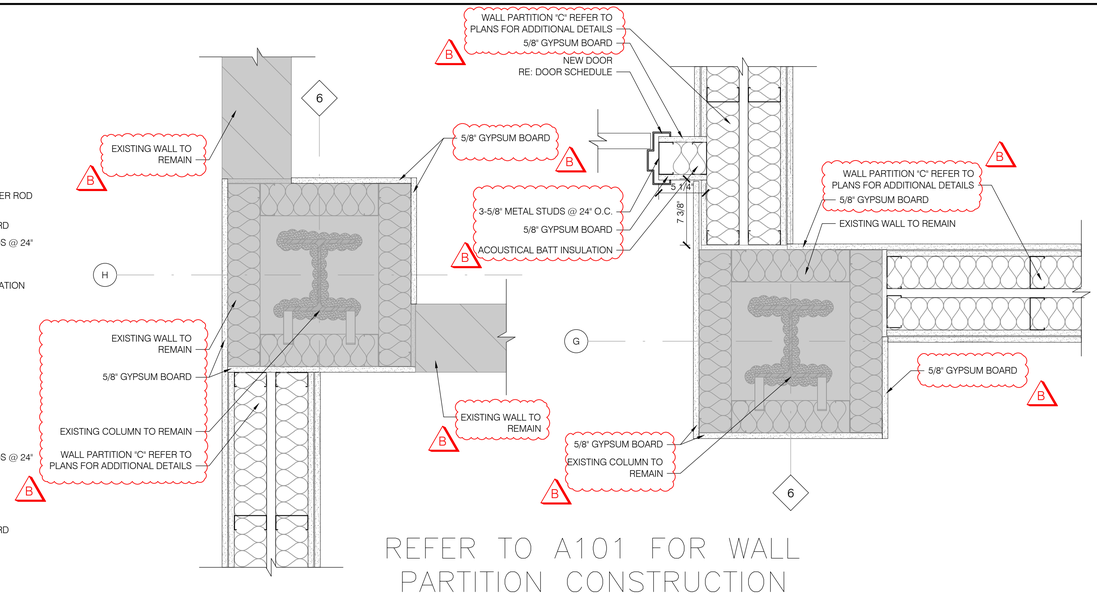
Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A601

File Location : X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_A601.dwg Plot Date : Jan. 20, 2023 8:26am

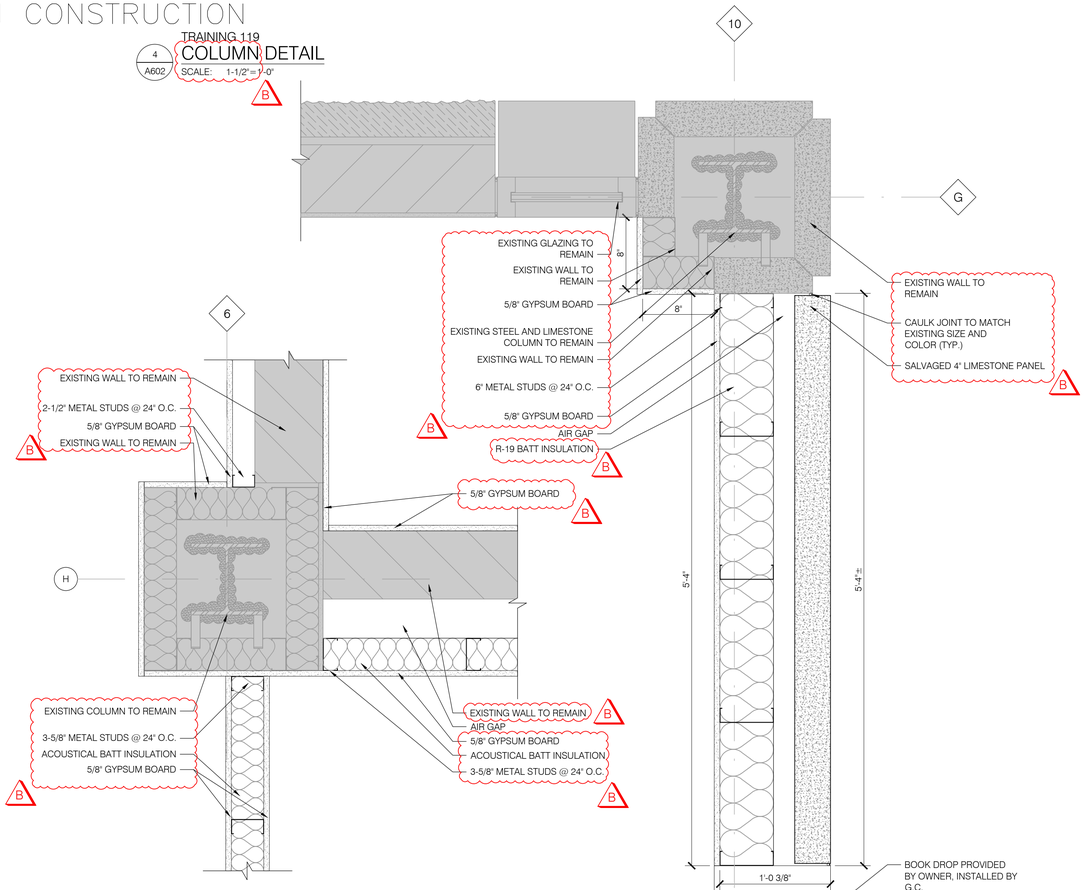


YOUTH STACKS 108
6 / A602 COLUMN DETAIL
SCALE: 1-1/2"=1'-0"

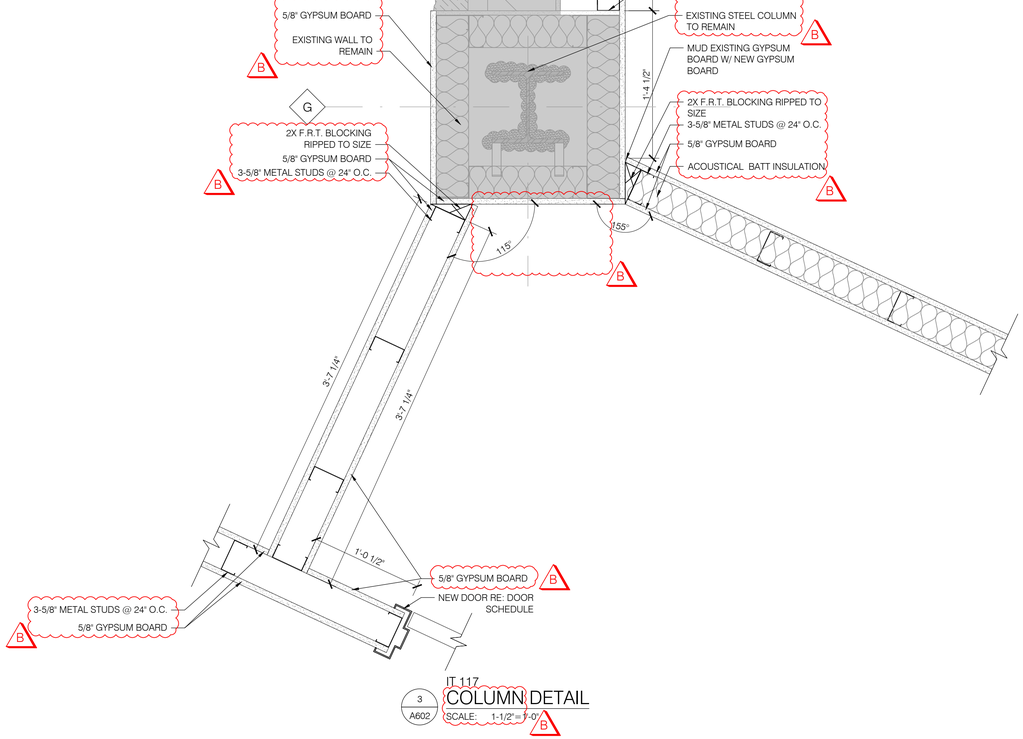


REFER TO A101 FOR WALL PARTITION CONSTRUCTION

VIDEO/PHOTO 122
5 / A602 COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



TRAINING 119
4 / A602 COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



IT 117
3 / A602 COLUMN DETAIL
SCALE: 1-1/2"=1'-0"

MAKERSPACE 125
2 / A602 COLUMN DETAIL
SCALE: 1-1/2"=1'-0"

VESTIBULE 137
1 / A602 BOOK DROP DETAIL
SCALE: 1-1/2"=1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. ALL WOOD BLOCKING TO BE FIRE TREATED.
C. ANY EXISTING SPRAY ON FIREPROOFING ON STRUCTURAL STEEL DISTURBED, FOR NEW CONSTRUCTION, MUST BE PATCHED.

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Greene County Public Library

XENIA COMMUNITY LIBRARY

76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS		
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

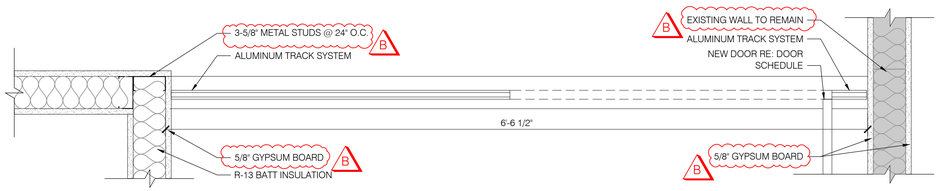
PRELIMINARY BID NOT FOR CONSTRUCTION

FIRST FLOOR PLAN DETAILS

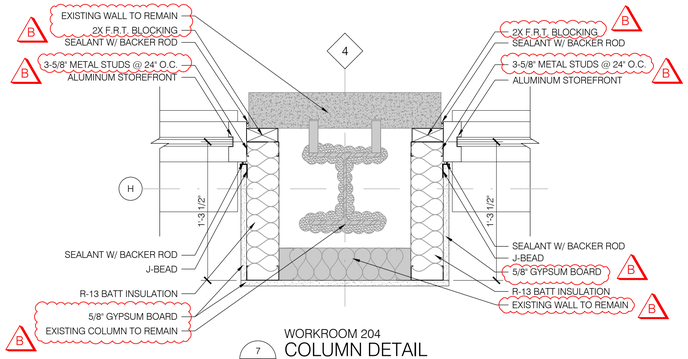
Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A602

File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_A601.dwg Plot Date : Jan. 20, 2023 8:27am



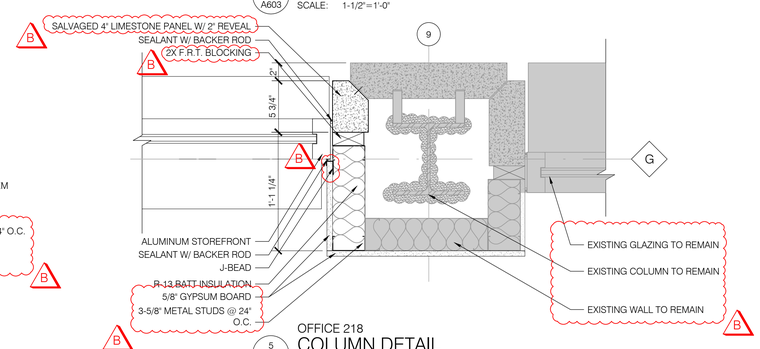
9 / A603 BOARD ROOM 239
PARTITION MULLION DETAIL
SCALE: 1-1/2"=1'-0"



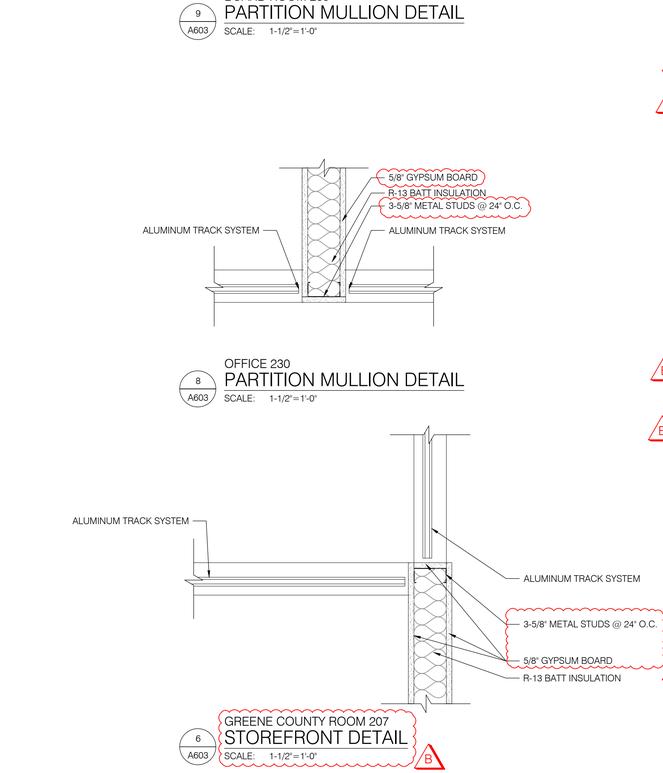
7 / A603 WORKROOM 204
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"

8 / A603 OFFICE 230
PARTITION MULLION DETAIL
SCALE: 1-1/2"=1'-0"

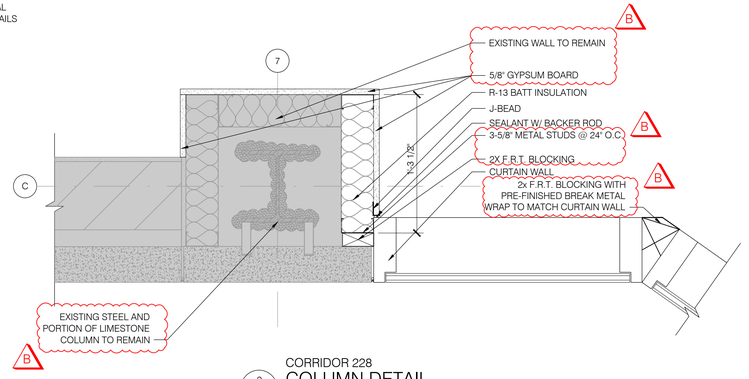
6 / A603 GREENE COUNTY ROOM 207
STOREFRONT DETAIL
SCALE: 1-1/2"=1'-0"



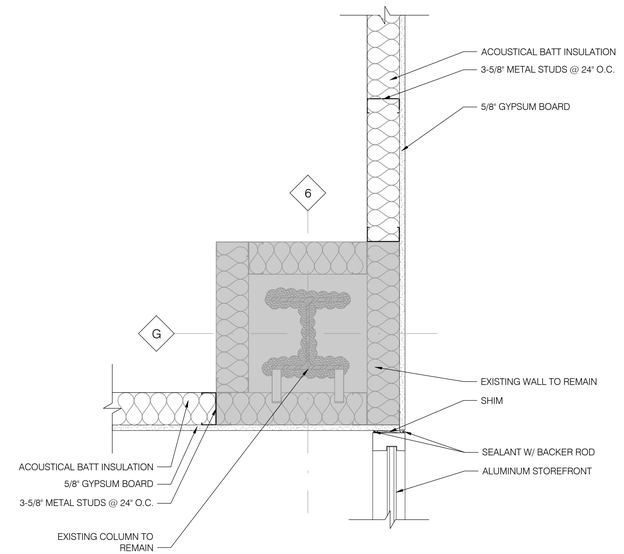
5 / A603 OFFICE 218
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



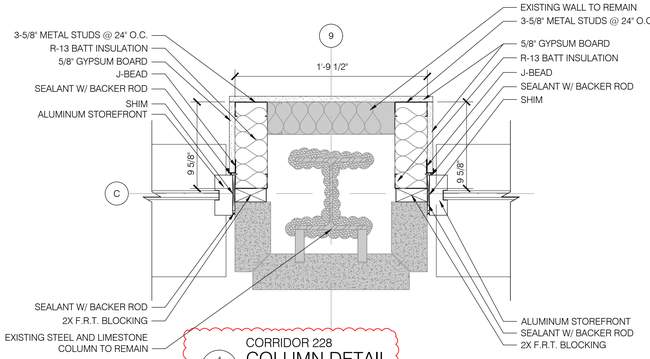
3 / A603 CORRIDOR 228
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



2 / A603 CORRIDOR 228
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



4 / A603 GREENE COUNTY ROOM 207
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"



1 / A603 CORRIDOR 228
COLUMN DETAIL
SCALE: 1-1/2"=1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. ALL WOOD BLOCKING TO BE FIRE TREATED.
C. ANY EXISTING SPRAY ON FIREPROOFING ON STRUCTURAL STEEL DISTURBED, FOR NEW CONSTRUCTION, MUST BE PATCHED.

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REVISIONS / SUBMISSIONS		
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

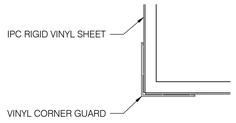
PRELIMINARY BID NOT FOR CONSTRUCTION

SECOND FLOOR PLAN DETAILS

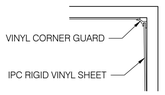
Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

A603

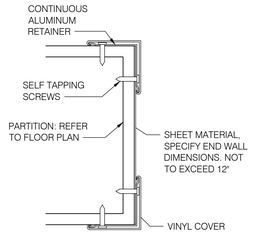
File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch
Filename : 21-2113_A601.dwg Plot Date : Jan. 20, 2023 8:30am



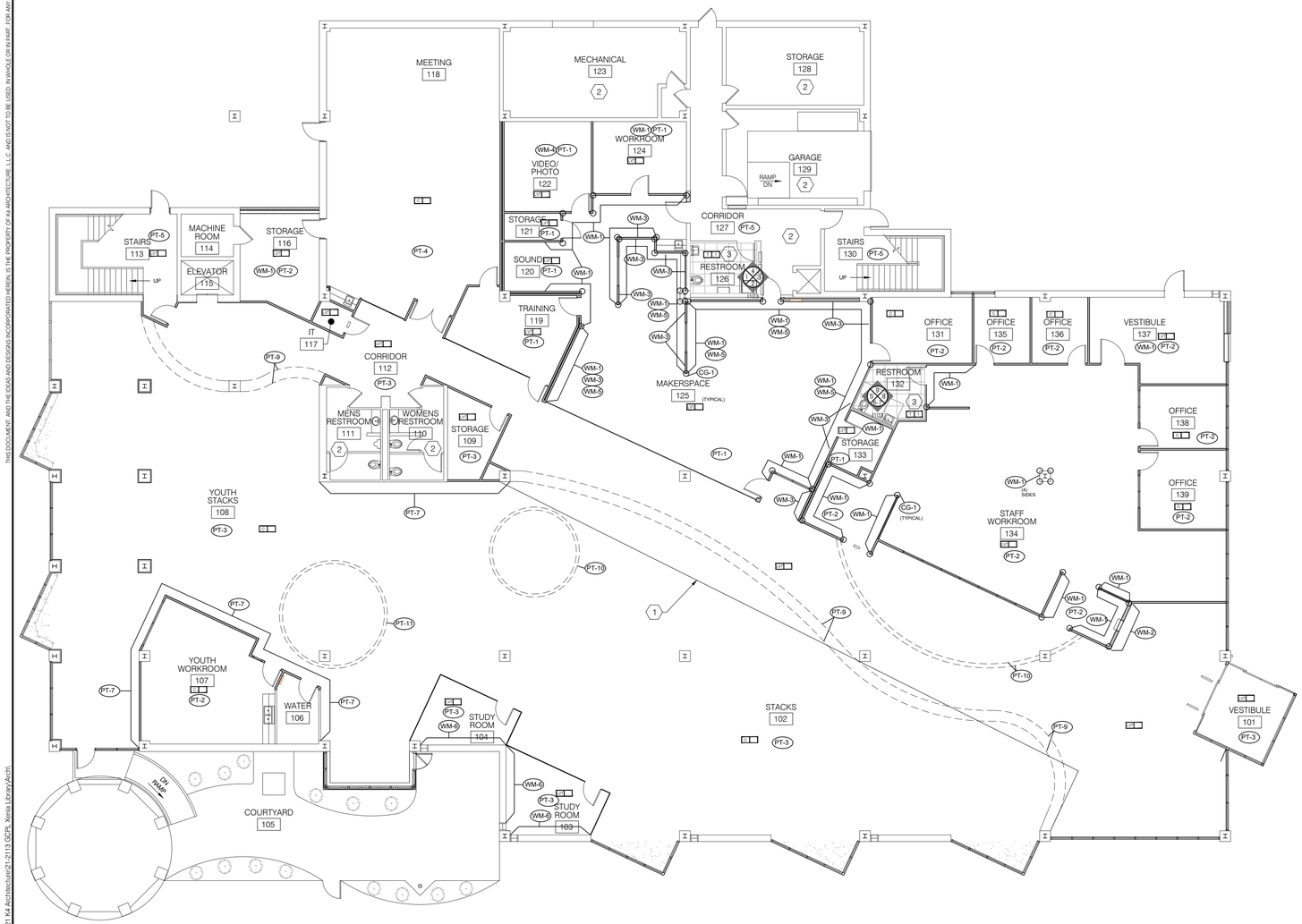
2 I101 OUTSIDE CORNER DETAIL
SCALE: 3"=1'-0"



3 I101 INSIDE CORNER DETAIL
SCALE: 3"=1'-0"



4 I101 END CAP DETAIL
SCALE: 3"=1'-0"



1 I101 FIRST FLOOR FINISH PLAN
SCALE: 3/32"=1'-0"

NOTES THIS DRAWING:

1. FLOOR TRANSITION BY OTHER.
2. EXISTING FLOOR TO REMAIN.
3. WALL TILE IN ALL RESTROOMS. SEE I103 FOR HEIGHT.

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. CARPET, LVT, AND BASE TO BE PROVIDED AND INSTALLED BY OWNER UNLESS NOTED OTHERWISE.
C. GC TO PROVIDE LEVEL FLOOR SURFACE FOR ALL OWNER SUPPLIED FLOORING MATERIALS.
D. ALL FLOORING TRANSITIONS TO OCCUR AT DOORWAYS UNO. USE APPROPRIATE TRANSITION STRIP AS NOTED.
E. PREPARE ALL SURFACES TO RECEIVE NEW FINISHES PER MANUFACTURER'S GUIDELINES.
F. ALL FINISHES PROVIDED AND INSTALLED BY GC SHALL BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS AND GUIDELINES.

FLOORING LEGEND:

LVT — LUXURY VINYL TILE BY OWNER.

C — CARPET BY OWNER.

WM — WALL MATERIAL. PROVIDED BY OWNER, INSTALLED BY GC. COORDINATE WITH OWNER VENDER ON FINAL LOCATIONS PRIOR TO INSTALLATION. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.

T # — CERAMIC TILE PROVIDED AND INSTALLED BY GC. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.

CG-1 — CORNER GUARD. PROVIDED AND INSTALLED BY GC

FINISH SCHEDULE

SYMBOL	MATERIAL	SPECIFICATION	CONTACT INFORMATION	REMARKS
C-1	WALK-OFF C-TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-2	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-3	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-4	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-5	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-1	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-2	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-3	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-4	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
B-1	RUBBER BASE	STYLE: TBD SIZE: 4"	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
B-2	RUBBER BASE	STYLE: TBD SIZE: 4"	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
TR-1	VINYL TRANSITION	NAME: TBD STYLE: TBD	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
TR-2	VINYL TRANSITION	NAME: TBD STYLE: TBD	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
CG-1	CORNER GUARD	STYLE: TBD COLOR: TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	SEE PLAN FOR OUTSIDE, INSIDE, AND END CAP LOCATIONS
WM-1	WALL PROTECTION	PATTERN: PALLADIUM RIGID VINYL ROLL 48" H, COLOR:TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	GC TO PROVIDE: CORNER GUARD, INSIDE CORNER, COLOR MATCH PROTECTOR AS RQ
WM-2	WALL PROTECTION	RICOCHET FLEXIBLE WALL PRO PASSAGE PASSAGE VERTICALLY INSTALL, COLOR: TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	PROVIDED AND INSTALLED BY GC
WM-3	SLAT WALL PANEL	GEARWALL PANELS, COLOR: TBD	GLADIATOR GARAGE WORKS WWW.GLADIATORGARAGEWORKS.COM	PROVIDED BY OWNER, GC TO INSTALL
WM-4	ACOUSTICAL PANEL	PATTERN: MUTO SLAB. 48"W x 110"H x 1"T COLOR: TBD	SOELBERG, #1-888-228-8207 MELANIE PROULX, #1-614-314-1083	GC TO PROVIDE: Z-CLIP INSTALLATION
WM-5	ACOUSTICAL TILE	PATTERN: ECOUSTIC BOND TILE SIZE: 19.7" x 19.7" x 2.2"D, COLORS: TDB	UNIKA VAEV, #1-800-237-1625 CANDY MCDOWELL, #1-614-266-6652	GC TO PROVIDE: ECOUSTIC BOND COMPON. AND 4-WAY CLIP SYSTEM, GC PROVIDE SCREWS
WM-6	ACOUSTICAL PANEL	PATTERN: MUTO TEXTURED 42"W x 96"H x 1/2"T COLOR: TBD	SOELBERG, #1-888-228-8207 MELANIE PROULX, #1-614-314-1083	GC TO PROVIDE: Z-CLIP INSTALLATION
PT-1	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-2	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-3	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-4	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-5	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-6	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-7	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-8	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-9	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-10	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-11	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-12	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-13	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-14	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-15	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-16	PAINT PRIMER	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-17	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-18	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-19	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-20	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
T-1	TILE (FLOOR)	LANDMARK CERAMICS, ATTITUDE 24" x 24" TILE, WARM SAND	AMANDA THOM, COMMERCIAL ACCT. SPECIALIST HAMILTON PARKER	PROVIDED AND INSTALLED BY GC
T-2	TILE (WALL)	DALTILE, UNITY 12" x 24" TILE, AVORIO P400	DALTILE GENERAL #877-556-5728 HTTPS://DALTILE.COM/	PROVIDED AND INSTALLED BY GC
T-3	COVE BASE TILE	DALTILE, UNITY 6" x 12" TILE, AVORIO P400	DALTILE GENERAL #877-556-5728 HTTPS://DALTILE.COM/	PROVIDED AND INSTALLED BY GC
T-4	TILE (FLOOR)	LANDMARK CERAMICS, ATTITUDE 24" x 24" TILE, COLOR: TBD	DALTILE GENERAL #877-556-5728 HTTPS://DALTILE.COM/	PROVIDED AND INSTALLED BY GC
SS-1	SOLID SURFACE	DUPOINT CORIAN SOLID SURFACE COLOR: TBD	DUPOINT, GENERAL# 1-800-899-8916 WWW.DUPOINT.COM	PROVIDED AND INSTALLED BY GC

K4 ARCHITECTURE + DESIGN
555 Gest Street
Cincinnati, Ohio 45203
Tel: (513) 455-5000
Fax: (513) 455-5008
Webpage: www.k4architecture.com
Email: info@k4architecture.com

COMPLETE RENOVATION/MECHANICAL UPGRADES:

Greene County Public Library

XENIA COMMUNITY LIBRARY
76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS			
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

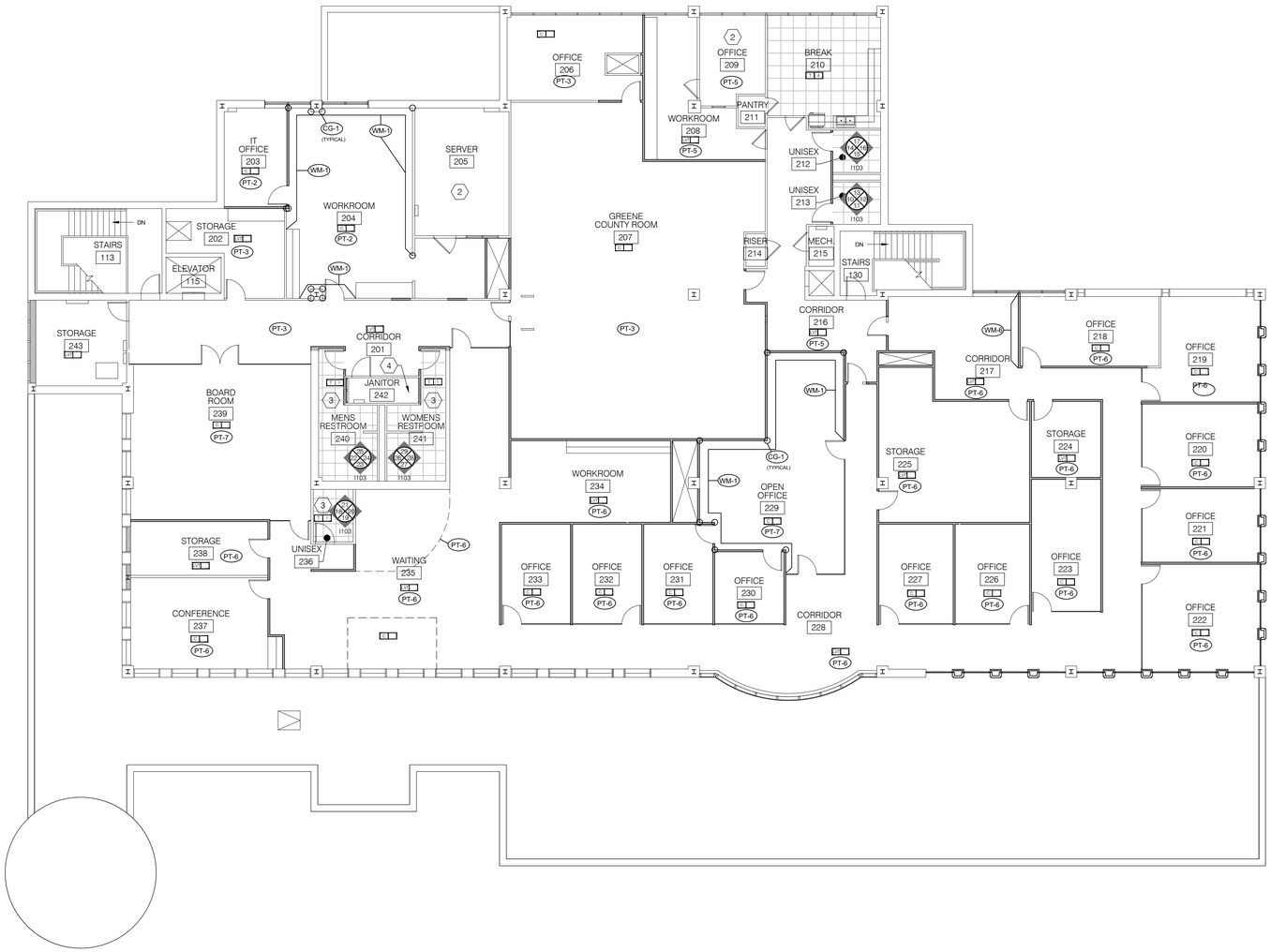
PRELIMINARY BID NOT FOR CONSTRUCTION

FIRST FLOOR FINISH PLAN

Drawn By: BBJ, TW
Scale: AS NOTED
Job No.: 21-2113

I101

File Location: X:\2021 Projects\2021 K4 Architecture\21-2113 GGPL Xenia Library\Arch\
Filename : 21-2113_I101.dwg Plot Date : Jan. 20, 2023 8:31am



1 / I102 SECOND FLOOR FINISH PLAN
SCALE: 3/32"=1'-0"

NOTES THIS DRAWING:

1. FLOOR TRANSITION BY OTHER.
2. EXISTING FLOOR TO REMAIN.
3. WALL TILE IN ALL RESTROOMS. SEE I103 FOR HEIGHT.
4. SEALED CONCRETE FLOOR.

GENERAL NOTES:

A. REFER TO T001 FOR ADDITIONAL GENERAL NOTES.
B. CARPET, LVT, AND BASE TO BE PROVIDED AND INSTALLED BY OWNER.
C. GC TO PROVIDE LEVEL FLOOR SURFACE FOR ALL OWNER SUPPLIED FLOORING MATERIALS.
D. ALL FLOORING TRANSITIONS TO OCCUR ST DOORWAYS UNO. USE APPROPRIATE TRANSITION STRIP AS NOTED.
E. PREPARE ALL SURFACES TO RECEIVE NEW FINISHES PER MANUFACTURER'S GUIDELINES.

FLOORING LEGEND:

LVT — LUXURY VINYL TILE BY OWNER.

C — CARPET BY OWNER.

WM — WALL MATERIAL. PROVIDED BY OWNER, INSTALLED BY GC. COORDINATE WITH OWNER VENDER ON FINAL LOCATIONS PRIOR TO INSTALLATION. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.

T # — CERAMIC TILE PROVIDED AND INSTALLED BY GC. RE: SPECIFICATIONS FOR ADDITIONAL DETAIL.

CG-1 — CORNER GUARD. PROVIDED AND INSTALLED BY GC

FINISH SCHEDULE

SYMBOL	MATERIAL	SPECIFICATION	CONTACT INFORMATION	REMARKS
C-1	WALK-OFF C-TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-2	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-3	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-4	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
C-5	CARPET TILE	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-1	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-2	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-3	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
V-4	LVT	PATTERN: TBD SIZE:	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
B-1	RUBBER BASE	STYLE: TBD SIZE: 4"	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
B-2	RUBBER BASE	STYLE: TBD SIZE: 4"	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
TR-1	VINYL TRANSITION	NAME: TBD STYLE: TBD	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
TR-2	VINYL TRANSITION	NAME: TBD STYLE: TBD	MANUFACTURER: TBD	N.I.C. PROVIDED BY OTHER
CG-1	CORNER GUARD	STYLE: TBD COLOR: TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	SEE PLAN FOR OUTSIDE, INSIDE, AND END CAP LOCATIONS
WM-1	WALL PROTECTION	PATTERN: PALLADIUM RIGID VINYL ROLL 48" H, COLOR:TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	GC TO PROVIDE: CORNER GUARD, INSIDE CORNER, COLOR MATCH PROTECTOR AS REQ'D
WM-2	WALL PROTECTION	RICOCHET FLEXIBLE WALL PRO PASSAGE PASSAGE VERTICALLY INSTALL, COLOR: TBD	INPRO CORP. #1-800-222-5556 WWW.INPROCORP.COM	PROVIDED AND INSTALLED BY GC
WM-3	SLAT WALL PANEL	GEARWALL PANELS, COLOR: TBD	GLADIATOR GARAGE WORKS WWW.GLADIATORGARAGEWORKS.COM	PROVIDED BY OWNER, GC TO INSTALL
WM-4	ACOUSTICAL PANEL	PATTERN: MUTO SLAB. 48"W x 110"H x 1"T COLOR: TBD	SOELBERG, #1-888-228-8207 MELANIE PROULX, #1-614-314-1083	GC TO PROVIDE: Z-CLIP INSTALLATION
WM-5	ACOUSTICAL TILE	PATTERN: ECOUSTIC BOND TILE SIZE: 19.7" x 19.7" x 2.2"D, COLORS: TDB	UNIKA VAEV, #1-800-237-1625 CANDY MCDOWELL, #1-614-266-6652	GC TO PROVIDE: ECOUSTIC BOND COMPON. AND 4-WAY CLIP SYSTEM, GC PTOVIDE SCREWS
WM-6	ACOUSTICAL PANEL	PATTERN: MUTO TEXTURED 42"W x 96"H x 1/2"T COLOR: TBD	SOELBERG, #1-888-228-8207 MELANIE PROULX, #1-614-314-1083	GC TO PROVIDE: Z-CLIP INSTALLATION
PT-1	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-2	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-3	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-4	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-5	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-6	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-7	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-8	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-9	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-10	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-11	WALL PAINT	SHERWIN WILLIAMS, EGGSHELL FINISH COLOR: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-12	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-13	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-14	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-15	CEILING PAINT	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-16	PAINT PRIMER	SHERWIN WILLIAMS, MATTE FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-17	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-18	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-19	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
PT-20	PAINT	SHERWIN WILLIAMS, SATIN FINISH COLOR: TBD LOCAL: TBD	SHERWIN WILLIAMS,#1-800-4SHERWIN WWW.SHERWIN-WILLIAMS.COM	PROVIDED AND INSTALLED BY GC
T-1	TILE (FLOOR)	LANDMARK CERAMICS, ATTITUDE 24" x 24" TILE, WARM SAND	AMANDA THOM, COMMERCIAL ACCT. SPECIALIST HAMILTON PARKER	PROVIDED AND INSTALLED BY GC
T-2	TILE (WALL)	DALTILE, UNITY 12" x 24" TILE, AVORIO P400	DALTILE GENERAL #877-556-5728 HTTPS://DALTILE.COM/	PROVIDED AND INSTALLED BY GC
T-3	COVE BASE TILE	DALTILE, UNITY 6" x 12" TILE, AVORIO P400	DALTILE GENERAL #877-556-5728 HTTPS://DALTILE.COM/	PROVIDED AND INSTALLED BY GC
T-4	TILE (FLOOR)	LANDMARK CERAMICS, ATTITUDE 24" x 24" TILE, COLOR: TBD	DUPOINT, GENERAL# 1-800-899-8916 WWW.DUPOINT.COM	PROVIDED AND INSTALLED BY GC
SS-1	SOLID SURFACE	DUPOINT CORIAN SOLID SURFACE COLOR: TBD	DUPOINT, GENERAL# 1-800-899-8916 WWW.DUPOINT.COM	PROVIDED AND INSTALLED BY GC

ARCHITECTURE + DESIGN
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Email: info@k4architecture.com

COMPLETE RENOVATION/MECHANICAL UPGRADES:

Greene County Public Library

XENIA COMMUNITY LIBRARY
76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS		
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	1/20/23

PRELIMINARY BID NOT FOR CONSTRUCTION

SECOND FLOOR FINISH PLAN

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

I102

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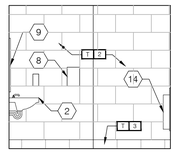

29 / I103 WOMENS RESTROOM 241 ELEVATION
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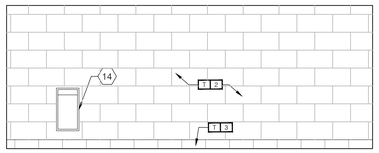

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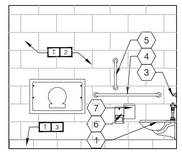

27 / I103 WOMENS RESTROOM 241 ELEVATION
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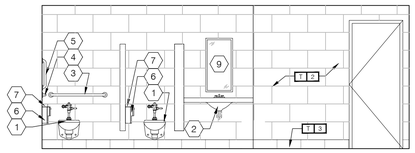

26 / I103 WOMENS RESTROOM 241 ELEVATION
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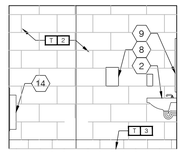

25 / I103 MENS RESTROOM 240 ELEVATION
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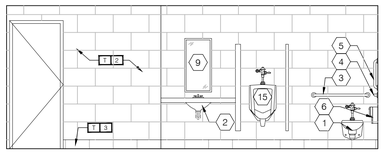

24 / I103 MENS RESTROOM 240 ELEVATION
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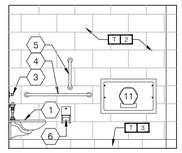

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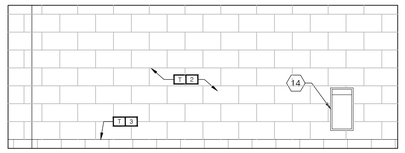

22 / I103 MENS RESTROOM 240 ELEVATION
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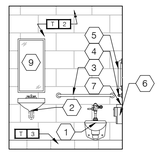

21 / I103 UNISEX 236 ELEVATION
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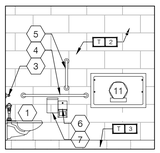

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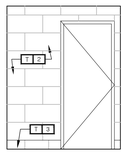

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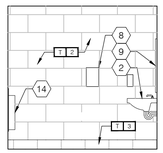

18 / I103 UNISEX 236 ELEVATION
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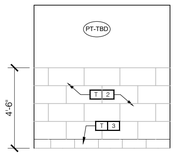

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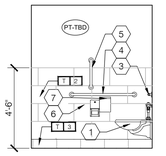

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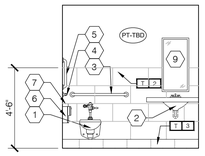

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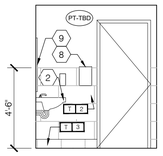

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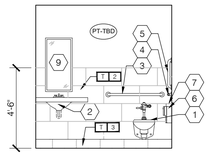

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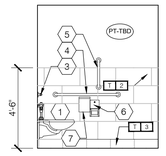

12 / I103 UNISEX 213 ELEVATION
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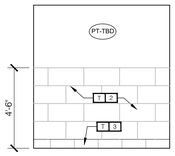

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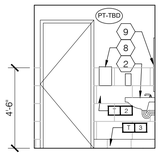

10 / I103 UNISEX 213 ELEVATION
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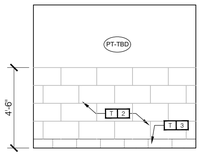

9 / I103 RESTROOM 132 ELEVATION
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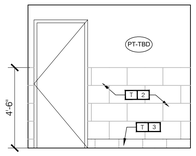

8 / I103 RESTROOM 132 ELEVATION
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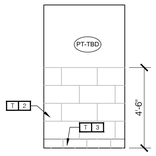

7 / I103 RESTROOM 132 ELEVATION
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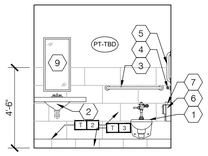

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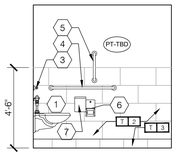
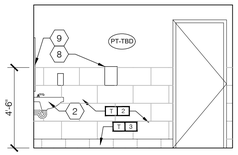
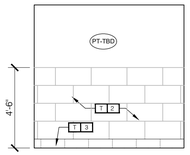


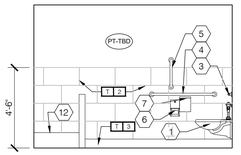
5 / I103 RESTROOM 132 ELEVATION
SCALE: 1/4" = 1'-0"



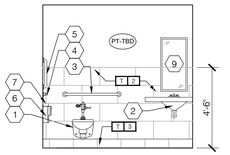
4 / I103 RESTROOM 126 ELEVATION
SCALE: 1/4" = 1'-0"



3 / I103 RESTROOM 126 ELEVATION
SCALE: 1/4" = 1'-0"



2 / I103 RESTROOM 126 ELEVATION
SCALE: 1/4" = 1'-0"



1 / I103 RESTROOM 126 ELEVATION
SCALE: 1/4" = 1'-0"

GENERAL NOTES:

A. REFER TO T001 FOR MORE GENERAL NOTES.
B. REFER TO INTERIOR FINISH PLANS AND FINISH SCHEDULE FOR FLOORING MATERIAL, WALL FINISHES AND PAINT COLOR.
C. PROVIDE 2X BLOCKING @ ALL WALL HUNG CASEWORK, FIXTURES, AND SHELVES.

NOTES THIS DRAWING:

1. ADA ACCESSIBLE WATER CLOSET.
2. UNDER MOUNT LAVATORY SINK.
3. 36" GRAB BAR.
4. 42" GRAB BAR.
5. 18" VERTICAL GRAB BAR.
6. TOILET TISSUE DISPENSER.
7. SANITARY NAPKIN DISPOSAL.
8. PAPER TOWEL DISPENSER.
9. MIRROR.
10. WALL MOUNTED TACTILE/BRAILLE RESTROOM SIGNAGE. PROVIDE ACCESSIBLE SIGNAGE PER ADA GUIDELINES.
11. WALL MOUNTED BABY CHANGING STATION.
12. MOP SINK
13. TILE WAINSCOT.
14. WASTE RECEPTACLE.
15. URINAL.

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COMPLETE RENOVATION/MECHANICAL UPGRADES:
Greene County Public Library
XENIA COMMUNITY LIBRARY
76 EAST MARKET STREET
XENIA, OH 45385

REVISIONS / SUBMISSIONS		
NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

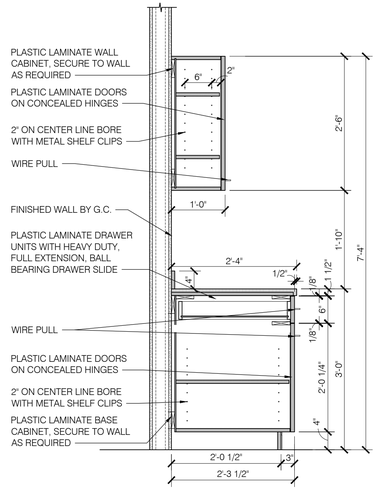
PRELIMINARY BID NOT FOR CONSTRUCTION

RESTROOM ELEVATIONS

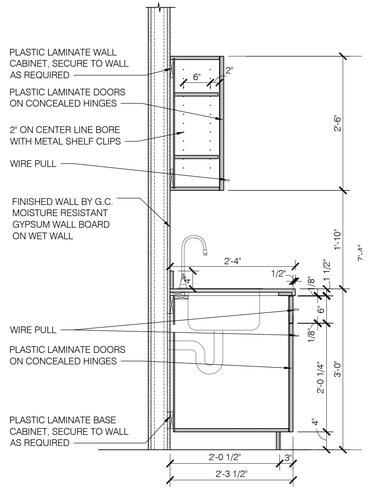
Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

I103

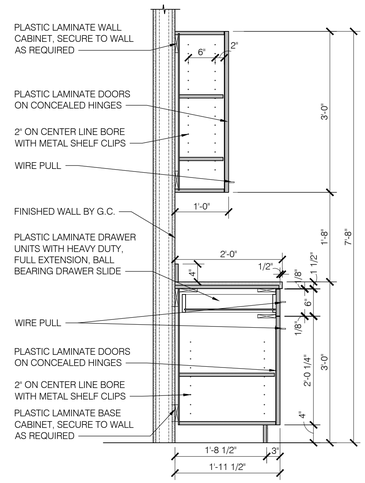
Filename : 21-2113_I101.dwg Plot Date : Jan. 20, 2023 8:32am



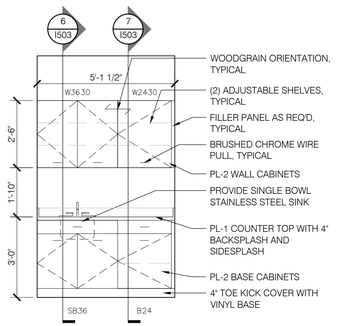
7 / I503 CONFERENCE 237 SECTION
SCALE: 3/4" = 1'-0"



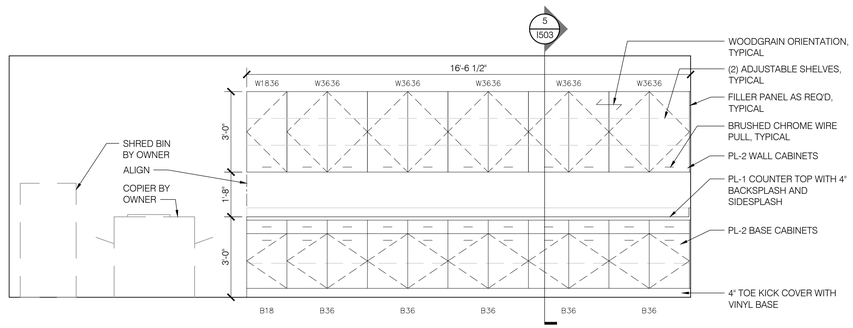
6 / I503 CONFERENCE 237 SECTION
SCALE: 3/4" = 1'-0"



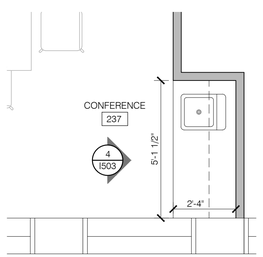
5 / I503 WORKROOM 234 SECTION
SCALE: 3/4" = 1'-0"



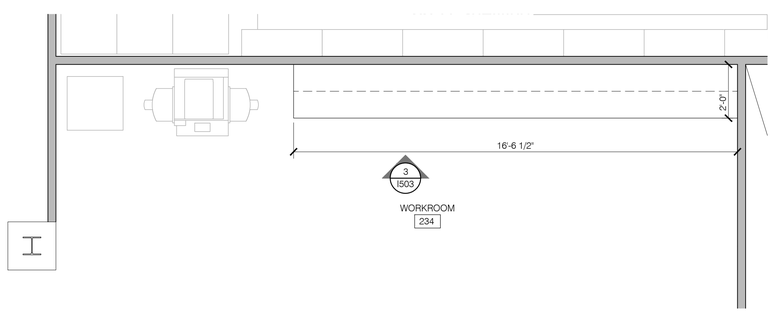
4 / I503 CONFERENCE 237 ELEVATION
SCALE: 3/8" = 1'-0"



3 / I503 WORKROOM 234 ELEVATION
SCALE: 3/8" = 1'-0"



2 / I503 CONFERENCE 237 ENLARGED PLAN
SCALE: 3/8" = 1'-0"



1 / I503 WORKROOM 234 ENLARGED PLAN
SCALE: 3/8" = 1'-0"

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NO.	DESCRIPTION	DATE
	BID ISSUE	01/04/23
B	ADDENDUM B	01/20/23

PRELIMINARY BID NOT FOR CONSTRUCTION

CASEWORK PLANS, SECTIONS, & DETAILS

Drawn By:	BBJ, TW
Scale:	AS NOTED
Job No.:	21-2113

I503

File Location: K:\2021 Projects\2021 K4 Architecture\21-2113 GCPL Xenia Library\Arch\
Filename : 21-2113_I501.dwg Plot Date : Jan. 20, 2023 9:02am