

BVH ARCHITECTURE

ADDENDUM

ADDENDUM NO.: #02

DATE: 09/12/2024

PROJECT: NDOT 1600 Renovation

PROJECT #: 23053

TO: Prospective Bidders

This Addendum is issued by the Architect to all bidders of record prior to receipt of proposals. Bidders shall acknowledge receipt of this addendum by so indicating on the Proposal Form. Failure to do so may subject Bidder to disqualification. All information and instructions given herein shall become a part of the Contract Documents.

GENERAL

1. The Buy America Act and BABA do not apply to this project.
2. Project to be completed 480 days from notice to proceed. This applies to all specs and bid form. Revised bid form attached.

PROJECT MANUAL

1. Section 00 40 00 - Proposal Form
 - a. The proposal form is being reissued as the date for substantial completion has been changed to 480 days from the issuance of the Notice to Proceed. This form (attached) shall be used by bidders to offer their bids.
2. Section 101423 - Panel Signage.
 - a. This section is being reissued in its entirety.
3. Section 084313 - Aluminum-Framed Storefront.
 - a. Change article 2.04, D., 2 as follows:
 - i. Top Rail: 5 inches wide.
 - b. Change article 2.06 as follows:
 - i. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.
4. Section 087100 - Door Hardware
 - a. Door hardware set 18.0 to be revised to include panic hardware:

Set: 18.0

Doors: 005

3 Hinge, Full Mortise, Hvy Wt [T4A3786 4-1/2" x 4-1/2"](#) US26D MK

1 Rim Exit Device, Storage [12 8815 ETL](#) US32D SA

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1 Surface Closer w/ Hold Open	351 CPSH	EN	SA
1 Kick Plate	K1050 10" x 2" LDW CSK BEV US32D RO		
3 Silencer	608-RKW		RO

5. Section 085113 - Aluminum Windows.
 - a. This section is being added in its entirety.
6. Section 092116 - Gypsum Board Assemblies.
 - a. Add the following article to this section as 2.04, E.
 - i. E. Decorative Metal Trim:
 1. Material: Extruded aluminum alloy 6063-T5 temper.
 2. Finish: Anodized, clear.
 3. Basis of Design-Fry Reglet J Molding.
 - a. Additional Manufacturers:
 - 1) Gordon Inc[<>]: www.gordon-inc.com/#sle.
 - 2) Substitutions: See Section 016000-Product Requirements.
7. Section 099123 - Interior Painting.
 - a. Remove the following article. 2.03,B.
 - i. 2.03 Paint Systems-Interior
 - B. Existing Quarry Tile:
 1. Two top coats and one primer coat.
 2. Primer: Waterborne, urethane modified acrylic primer.
 - a. Sherwin Williams Extreme Bond Interior-Exterior Bonding Primer.
 3. Top Coats: Water-Based Catalyzed Epoxy. Two-component polyamine epoxy topcoat.
 - a. Sherwin Williams Pro Industrial Water Based Catalyzed Epoxy.
8. SECTION 230923 – Direct Digital Control (DDC) System for HVAC
 - a. Removed all other manufacturers except Johnson Controls (JCI).
9. SECTION 233300 – Air Duct Accessories
 - a. Added subparagraph for aluminum volume dampers.
10. SECTION 235216 – Condensing Boilers
 - a. Add subparagraphs for boiler circulation pumps and combustion optimization.
11. SECTION 236433 – Modular Water Chillers
 - a. Updated references to compressors to be “variable speed scroll”.
 - b. Removed references to rotary screw compressors.
 - c. Add language for article 2.03.
12. SECTION 236514.14 – Cooling Towers

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- a. Updates collection and distribution basins to stainless steel.
 - b. Added paragraph 2.06.A.
 - c. Modified article 2.09.
 - d. Modified sub-paragraph 2.11.B.3.
 - e. Modified paragraph 2.13.A.
 - f. Modified paragraph 2.14.B.
13. SECTION 271500 – Communications Cabling
- a. Revise paragraph 2.02.F as follows: “Horizontal Copper Cable: Category 6, CMP, blue for data. Category 6A, CMP, green for WAPs.”
 - b. Revise sub-paragraph 2.02.F.1 as follows: “Comply with TIA/EIA-568-B.2, Category 6/6A.”
 - c. Revise sub-paragraph 2.02.H.2 as follows: “Category 6, blue for data cabling. Category 6A, green for WAP cabling.”

DRAWINGS

1. Sheet G1.1 WALL TYPES & DRAFTING STANDARDS
 - a. Addition of new wall type G10
2. Sheet AD1.0 DEMOLITION PLAN - LOWER LEVEL
 - a. Revision in stairwells to remove quarry tile
3. Sheet AD1.1 DEMOLITION PLAN - FIRST FLOOR
 - a. Revision in stairwells to remove quarry tile
4. Sheet AD1.2 DEMOLITION PLAN - SECOND FLOOR
 - a. Revision in stairwells to remove quarry tile
5. Sheet A0.1 ARCHITECTURAL SITE PLAN
 - a. Location added to coordinate sprinkler valve
 - b. Paint north driveway wall to match existing
 - c. Removed work for ADA parking. This will not be part of this project scope.
6. Sheet A1.0 LOWER LEVEL PLAN
 - a. Addition of wall type G10 at stairwell locations
 - b. Addition of note for new handrails at stairwells
7. Sheet A1.1 FIRST FLOOR PLAN
 - a. Called out location of ADA actuator at door 100B
 - b. Addition of plan note 4 at stairwell locations
 - c. Addition of wall type G10 at stairwell locations
8. Sheet A1.2 SECOND FLOOR PLAN
 - a. Addition of wall type G10 at stairwell locations
9. Sheet A2.1 ENLARGED PLANS, INTERIOR ELEVATIONS & DETAILS
 - a. Added Base detail 14
10. Sheet A3.1 BUILDING ELEVATIONS
 - a. Window types have been modified
11. Sheet A7.1 DOOR AND WINDOW FRAME TYPES/DETAILS
 - a. Window types have been modified
12. Sheet A9.1 FIRST FLOOR FINISH PLAN

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- a. Removal of note for EP2 at quarry tile
 - b. Addition of WTS-3
 - c. Removed EP-2 from project
- 13. Sheet A9.2 LOWER LEVEL FLOOR FINISH PLAN
 - a. Removal of note for EP2 at quarry tile
- 14. Sheet A9.3 SECOND FLOOR FINISH PLAN
 - a. Removal of note for EP2 at quarry tile
- 15. GM0.0 – General Mechanical Information
 - a. Add system abbreviation for blowdown piping.
 - b. Updated roof plan sheet name and number.
- 16. PD1.1 – Plumbing Demolition Plan – First Floor
 - a. Added in missing drop symbol for piping.
- 17. P1.0 – Plumbing Plan – Lower Level
 - a. Updated line style for SCW piping in MECHANICAL 006.
- 18. P1.1 – Plumbing Plan – First Floor
 - a. Shifted pipe drop to wall.
- 19. P1.2 – Plumbing Plan – Second Floor
 - a. Updated keynote near electrical panel to note 3.
- 20. M1.0 – HVAC Plan – Lower Level
 - a. Removed single point power panel for chillers.
- 21. M1.1 – HVAC Plan – First Floor
 - a. Added fire and volume damper for exhaust duct serving JAN 103.
- 22. M1.2 – HVAC Plan – Second Floor
 - a. Updates to ductwork and fan coil location.
 - b. Added fire dampers for ductwork.
- 23. M1.3 – Mechanical and Plumbing Plan – Roof
 - a. Updated sheet name and number.
 - b. Added heat trace to blowdown piping.
 - c. Updated note for different model of heat trace.
- 24. M2.0 – Mechanical Piping Plan – Lower Level
 - a. Updated sizes of hydronic piping.
- 25. M2.1 – Mechanical Piping Plan – First Floor
 - a. Updated sizes of hydronic piping.
 - b. Updated keynote 5.
- 26. M2.2 – Mechanical Piping Plan – Second Floor
 - a. Added keynote 1 near capped piping for future provision.
- 27. M3.1 – Mechanical Enlarged Plans
 - a. Removed single point power panel for chillers.
 - b. Updated keynote 1 to “Not Used”.
 - c. Update buffer tank tag.
- 28. M4.1 – Mechanical P&IDs
 - a. Updates to diagrams, sequences, and points lists.
- 29. M4.2 – Mechanical P&IDs

- a. Updates to diagrams, sequences, and points lists.
- 30. M5.1 – Mechanical Details
 - a. Clarified type of backflow preventer in detail 3.
- 31. M5.2 – Mechanical Details
 - a. Update locations of coils in detail 1.
 - b. Updated details 5 and 6 to boiler and chiller piping details.
 - c. Updated details 6 notes.
- 32. M6.1 – Mechanical Schedules
 - a. Revised schedules for plumbing fixtures, chillers, cooling tower, fan coil units, DOAS, split system condensing units, air devices, expansion tanks, and boilers.
- 33. E0.0 – Electrical Symbols and Abbreviations
 - a. Removed text “, with mounting hardware” from Security Video Camera symbol definition.
 - b. Added Lighting Control Zone tag definition to Abbreviations/Modifiers Schedule.
 - c. Add General Systems Note for cable types and colors.
- 34. ED1.1 – First Floor – Demolition Plan – Electrical
 - a. Added existing exterior, wall-mounted lights to plan with corresponding notes.
 - b. Added existing exterior security camera with corresponding notes.
- 35. E1.1 – First Floor – Lighting Plan
 - a. Added existing exterior, wall-mounted lights to plan with corresponding notes.
 - b. Removed (2) ceiling mounted lighting inverters and placed (1) wall-mount lighting inverter in Elec Room 104.
 - c. Added night light (“NL”) designations to select fixtures in corridors.
 - d. Added push button light switch locations in corridors.
 - e. Added Exterior Egress (“EGR”) lighting control zone tags to exterior light fixtures.
- 36. E2.1 – First Floor – Power Plan
 - a. Added electrical connections for Motorized ADA Door Operator for Door 100B.
- 37. E3.0 – Lower Level – Special Systems Plan
 - a. Added network drop for Building Management System.
 - b. Added duct detector for DOAS.
- 38. E3.1 – First Floor – Special Systems Plan
 - a. Added (3) cable locations for owner provided CCTV Cameras.
 - b. Added Wireless Access Point location in Room 110.
 - c. Added existing exterior security camera with corresponding notes.
- 39. E7.1 – Electrical Schedules
 - a. Added Fixture Type H1 information to Lighting Fixture Schedule.
 - b. Added Exterior Egress sequence of operation to Lighting Control Schedule.
 - c. Modified other miscellaneous sequence of operation information and notes.
- 40. E7.3 – Electrical Schedules
 - a. Added circuit to Panel 1M for Door 100B ADA Operator.

END OF ADDENDUM

PROPOSAL FORM

PROJECT IDENTIFICATION:

NDOT Project Number: AFE K - 002

NEBRASKA DEPARTMENT OF TRANSPORTATION - DISTRICT 0

NDOT 1600 Office Renovation

For furnishing all labor, equipment and material necessary for construction of the above listed project.

Submit proposal to:

Nebraska Department of Transportation

Operations Division

Capital Facilities Section

5001 S. 14th Street

Lincoln, Nebraska 68509

Phone: 402.479.3746

Proposal from:

(Bidder/Company)

(Address)

(City/State)

(Contact Name)

(Phone Number)

ACKNOWLEDGEMENTS

The below signed Bidder (Bidder) has thoroughly examined the Instructions to Bidders, drawings and specifications, all issued addendums (at the officially designated plan room service), general and supplemental conditions, and other proposed contract documents. Bidder has carefully examined the project location and its existing conditions, and understands the classes of materials required to complete the proposed work. Bidder agrees to provide all necessary machinery, tools, apparatus, services, and other means of construction to complete the work; and, to complete the work and furnish all the materials in accordance with the contract documents and specifications for the lump sum amount(s) contained in this Proposal Form.

Bidder has carefully checked the amount(s) contained on this Proposal Form and certifies that the bids are accurate and correct. Submitted bids are final and will remain firm for sixty (60) calendar days following the bid date. Bidder understands that NDOT reserves the right to reject or accept any or all bids, to waive any or all technicalities in the bidding procedure, or to accept any alternate bid items (ABI), in any order or quantity.

Bidder has reviewed the exemption of sales taxes to the State of Nebraska, and the requirements for registration of any non-resident contractors and subcontractors with Nebraska Department of Revenue. Bidder certifies that his business is in compliance with the Nebraska Fair Labor Standards Act and will continue to comply with that Act in execution of this contract.

Bidder agrees to enter into an agreement with NDOT within fifteen (15) calendar days of receipt of Notice of Acceptance of this bid proposal. This agreement will be executed on NDOT (Standard Form of Agreement Between Owner and Contractor), and delivered with the required Performance Bond and Payment Bond (AIA Document A312) in the amount of one hundred percent (100%) of the contract amount.

BID SECURITY

Bid Security of five percent (5%) of the bid amount is attached to this Proposal Form, as required in the Instructions to Bidders

PROJECT TIME COMPLETION

Notice to Proceed is anticipated to be issued within sixty (60) calendar days after the advertised bid opening date. Bidder agrees to substantially complete the proposed work within **480 Calendar days** following issuance of the Notice to Proceed.

NONCOLLUSION DECLARATION

Bidder hereby certifies that he or she has not, nor has any other member, representative, or agent of the firm, company, corporation or partnership represented by him or her, enter into any combination, collusion, or agreement with any person relative to the price of this bid. Nor has Bidder prevented any person from bidding, or induce anyone to refrain from bidding on this contract. This bid was made without reference to any other bid, and without any agreement, understanding, or combination with any other person in reference to this bid. No person, or persons, firms or

corporations has, have, or will receive directly or indirectly, any rebate, fee, gift, commission, or thing of value on account this bid.

FAIR LABOR STANDARDS CERTIFICATION

By signing this bid, the bidder certifies that the bidder is complying with and will continue to comply with Fair Labor Standards in pursuit of business and in the execution of this contract.

Base Bid:

_____ \$ _____
(enter bid amount in both words and numbers)

BID SIGNATURE

This single signature is certification of bid and bidding requirements.

(a) If an individual doing business as:

(Signature)

Business Address Telephone Number

(b) If a Partnership:

Member of Firm (Signature)

Member of Firm (Signature)

Business Address Telephone Number

(c) If a Corporation:

Name of Corporation

Person in Authority (Signature)

Title

Business Address Telephone Number

Notarization of above bid signature

STATE OF _____, COUNTY OF _____

On the _____ day of _____ 20_____, before me personally appeared the above

named _____ and being first duly sworn stated that the above statements are correct and true.

Notary Public

**SECTION 085113
ALUMINUM WINDOWS**

PART 1 - GENERAL

1.01 SUMMARY

- A. The Conditions of the Contract, and all Sections of Division 1, are hereby made a part of this Section.
- B. Section Includes: Factory glazed windows complete with reinforcing, shims, anchors, and attachment devices.
- C. Related Sections:
 - 1. Division 7 Section "Joint Sealants."
 - 2. Division 8 Section "Glass and Glazing."
- D. Coordinate work with that of all construction contractors affecting or affected by work of this Contract.

1.02 SYSTEM DESCRIPTION

- A. General: In addition to requirements shown or specified comply with sitelines and profiles indicated on contract documents.
- B. Design Requirements:
 - 1. Manufacturer/subcontractor is responsible for designing system, including installation instructions and necessary modifications to meet specified requirements and maintain visual design concepts.
 - 2. Requirements shown by details are intended specifically to establish dimension of unit, sight lines and profiles of members.
 - 3. Provide assemblies free from rattles, wind whistles and noise due to thermal and structural movement and wind pressure.
 - 4. Installation instructions are to take into account specified 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.
 - 5. Provide for expansion and contraction due to structural movement without detriment to appearance or performance.
 - 6. Evacuate water without infiltration to interior from exterior face of wall, water entering joints, and condensation occurring within windows, by drain holes and gutters of adequate size or other acceptable method.
 - 7. Provide concealed fastening wherever possible.
- C. Performance Requirements: Requirements for aluminum windows, terminology and standards of performance, and fabrication and workmanship are those specified and recommended in AAMA/WDMA/CSA 101/I.S.2/A440-08 and applicable general recommendations published by AAMA. Conform to more stringent of specified AAMA standards and following:
 - 1. Performance Class and Grade: CW-PG110
 - 2. Air Infiltration Test: Not exceed 0.10 cubic feet per minute per square foot when tested at a pressure of 6.24 psf. Perform tests in accordance with ASTM E 283 with the sash in a closed and locked position.
 - 3. Water Resistance Test: Subject window unit to a water resistance test in accordance with ASTM E 331 and E547 with no water passing the interior face of the window frame and no leakage as defined in the test method. Mount the glazed unit in its vertical position continuously supported around the perimeter and the sash placed in the fully closed and locked position. When a static pressure of 12 pounds per square foot has been stabilized, apply five gallons of water per square foot of window area to the exterior face of the unit for a period of 15 minutes.
 - 4. Uniform Load Deflection Test: ASTM E 330 at 110 pounds per square foot: No member deflection more than 1/175 of its span. Maintain test load for a period of 10 seconds resulting in no glass breakage, permanent damage of fasteners, hardware parts, support arms, actuating mechanisms or any other damage causing the window to be inoperable.

5. Uniform Load Structural Test: Apply a minimum exterior and interior uniform load of 165 pounds per square foot to the entire outside surface of the test unit. Maintain this test load for a period of 10 seconds. Results: No glass breakage, permanent damage of fasteners, hardware parts, support arms, actuating mechanisms, or any other damage causing the window to be inoperable. And no permanent deformation of any frame or vent member in excess of 0.2 percent of its span.
6. Life Cycle Test: Per AAMA 101 and AAMA 910, provide proof that the product meets the criteria including passing air and water tests at the conclusion of the cycle tests.
7. "U" Factor: Perform computer simulation in accordance with ANSI/NFRC 100-2017 on a 1200mm (47") x 1500 mm (59") maximum size window resulting in a whole window U-Factor of no more than 0.33 using soft coat low-E insulating glass, argon and a warm edge spacer.
8. Testing: Where manufacturer's standard window units comply with the above performance requirements and have been tested by an AAMA certified independent laboratory showing compliance with such tests. Submit copy of the test report for the operable vent windows signed by the independent laboratory.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, recommendations and standard details for aluminum window units.
- B. Shop Drawings: Submit shop drawings, including location floor plans or exterior wall elevations showing all window openings, typical unit elevations at 1/4 inch scale, and half size detail sections of every typical composite member. Show anchors, hardware, operators and other components as appropriate if not included in manufacturer's standard data. Include glazing details and standards for factory glazed units.
- C. Samples:
 1. Submit one sample of each required aluminum finish, on 3 x 3 inch long sections of extrusion shapes or aluminum sheets as required for window units.
 2. Submit additional samples, if and as directed by Architect, to show fabrication techniques, workmanship of component parts, and design of hardware and other exposed auxiliary items.
- D. Certifications: Submit certified test laboratory reports by independent laboratory substantiating performance of system. Include other supportive data as required or as necessary.
- E. Operations and Maintenance Information.
- F. Sample Warranty.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store and handle windows, mullions, panels, hardware and all pertinent items in strict compliance with the manufacturer's instructions.
- B. Protect units adequately against damage from the elements, construction activities and other hazards before, during and after installation.

1.05 WARRANTY

- A. Manufacturer's Warrantees: Submit written warrantees from window manufacturer for the following:
 1. Windows: Windows furnished are certified as fully warranted against any defects in material or workmanship under normal use and service for a period of one (1) year from date of Substantial Completion.
 2. Finish: The pigmented organic finishes on exposed surfaces of windows and component parts (such as panning, trim, mullions and the like) are certified as complying fully with requirements of AAMA 2604 for pigmented organic coating and fully warranted against chipping, peeling, cracking or blistering and fading for a period of ten (10) years from date of Substantial Completion.
 3. Insulated Glass: Warranted from visual obstruction due to internal moisture for a period of twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Series SR6700 fixed window as manufactured by Graham Architectural Products, York.
 - 1. Additional manufacturers:
 - a. Substitutions: See Section 016000 - Product Requirements.
- B. Thermal Barrier: Provides a continuous uninterrupted thermal barrier around the entire perimeter of the frame and all sash and not be bridged by any metal conductors at any point. Provide manufacturer's standard construction which has been in use on similar window units for a period of not less than three years, has been tested to demonstrate resistance to thermal conductance and condensation and has been tested to show adequate strength per AAMA 505.

2.02 MATERIALS

- A. Aluminum Extrusions: Alloy and temper recommended by window manufacturer for strength, corrosion resistance and application of required finish, but not less than 22,000 psi ultimate tensile strength, a yield of 16,000 psi. Comply with ASTM B 221.
- B. Fasteners: Aluminum, stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors and other components of window units.
 - 1. Do not use exposed fasteners on exterior except where unavoidable for application of hardware. Match finish of adjoining metal.
 - 2. Provide non-magnetic stainless steel, tamper-proof screws for exposed fasteners, where required, or special tamper-proof fasteners.
 - 3. Locate fasteners so as not to disturb the thermal barrier construction of windows.
- C. Anchors, Clips And Window Accessories: Depending on strength and corrosion-inhibiting requirements, fabricate units of aluminum, non-magnetic stainless steel or hot-dip zinc coated steel or iron complying with ASTM A 123.
- D. Compression Glazing Strips and Weatherstripping: At manufacturer's option, provide neoprene gaskets complying with ASTM D 2000 Designation 2BC415 to 3BC415, PVC gaskets complying with ASTM D2287, or expanded neoprene gaskets complying with ASTM C 509, Grade 4.
- E. Sealant:
 - 1. Unless otherwise indicated for sealants required within fabricated window units, provide elastomeric type as recommended by window manufacturer for joint size and movement, to remain permanently elastic, non-shrinking and non-migrating. Provide product complying with AAMA Specification 803 and 808.
 - 2. Refer to Division 7 for perimeter sealants between window units and surrounding construction.

2.03 WINDOW TYPES (OPERATION)

- A. Fixed Aluminum Windows or Panel Frames (F):
 - 1. No special hardware required.
 - 2. Minimum Wall Thickness: 0.80 inches.
 - 3. Minimum Frame Depth: 3.250 inches.

2.04 FABRICATION AND ACCESSORIES

- A. General: Provide manufacturer's standard fabrication and accessories which comply with specifications. Include complete system for assembly of components and anchorage of window units and provide complete pre-glazing at the factory.
- B. Window Material:
 - 1. Windows and Muntin Bars: Aluminum.
 - 2. Secondary Members (friction tabs, shoes, weatherstripping guides, etc.): Aluminum or a material compatible with aluminum.

3. Main Frame and Vent: Nominal thickness of not less than 0.80 inches, except for fin trim either integral or applied. The vent shall overlap muntin frame and perimeter frame.
 4. Vent Members: Not less than 2.250 inches in depth.
- C. Master Frame: Not less than 3.250 inches in depth.
- D. Thermal Barrier: Provides a continuous uninterrupted thermal barrier around the entire perimeter of the frame and all sash and shall not be bridged by any metal conductors at any point.
- E. Construction:
1. Assembly: Miter and seal vents with a non-hardening mastic, forming a watertight joint. Structurally reinforce corners of the vent with aluminum gusset blocks and chemically weld, followed by crimping. Mechanical fasteners are not allowed.
 2. Cope corners of the frame with two screws per corner into screw ports and back seal, forming a water-tight joint.
- F. Mullions - Other structural members: When mullion units occur, whether they are joined by integral mullions, independent mullions or by a combination of frame members, the resulting members must be capable of withstanding the load outlined under Uniform Load specified load requirements, without deflecting more than 1/175th of its span. When independent or integral mullions are used to join windows, the mullions shall contain a thermal barrier as specified. Sightline shall provided match to existing sightlines. Evidence of compliance may be by mathematical calculations.
- G. Glazing:
1. Pre-glaze all units (except insulated panels as required for installation) at the factory with insulated glass as follows:
 - a. Insulating Glass: Overall thickness of 1 inch with two lites of 3/16 inch or thicker if size and loading require.
 - 1) Provide acid etched glass on #2 surface.
 - (a) Acid Etch Texture: Velour (Medium).
 - 2) Primary Sealant: Polyisobutylene applied to the edge of the spacer.
 - 3) Secondary Sealant: Silicone.
 - 4) Air Spacer: Continuous metal spacer with formed corners and an in-line connector, containing desiccant.
 - 5) Argon filled air space
 2. Glaze units to allow for glass replacement without the use of special tools.
- H. Weather Protection:
1. Provide means of drainage for water and condensation which may accumulate in members of window units by use of two weeps per main frame member.
 2. Do not position other material in such a manner as to obstruct the weep holes function.
- I. Simulated True Muntin: The simulated muntin is a triple muntin system to simulate a true muntin appearance from exterior. Align muntins within the windows system and from window to window within an industry acceptable tolerance.
1. See drawings for muntin grid layout and spacing.
 2. Exterior Grids: Finish matching the window system. Fasten grid to sloped perimeter vent at each contact point. Two piece snap grids are not permitted as a substitute.
 - a. Profile: Standard Beveled. 0.517 inch depth. 0.812 inch width.
 3. Interior Grid: Width to match muntin x 0.062 inch aluminum bar or profile grid as applicable, finish to match window system.
 4. Muntin In-between Glass: Aluminum muntin in glass simulates glass perimeter spacer between interior and exterior applied grid. Machine and mechanically fasten the intersections of muntin grids. Fasten the grid to the sloped perimeter vent at each contact point. Color: Black

2.05 CASING COVER SYSTEM: (PANNING, TRIMS, RECEPTORS, MULLIONS, SILLS ETC.)

- A. Exterior Casing Covers (Panning, Receptors, Subsills, Sills, etc.): Provide extruded prime alloy aluminum 6063-T5 no less than nominal 0.078 inch wall thickness. Casing covers of less than

2 inches in depth from the window frame may be of 0.062 inch wall thickness.

1. Exposed screws, fasteners or pop rivets are not acceptable on the casing or mullion systems.
- B. Exterior mullion covers: Extruded aluminum shape to provide rigidity, no less than nominal 0.062 inch wall thickness. Seal against the window sections with continuous bulbous vinyl weatherstrip interlocked within the mullion cover and sealant as required for a watertight installation.
- C. Interior trim:
 1. Interior Trim, Closures and Angles: As detailed, of extruded shapes no less than 0.062 inch nominal wall thickness or as required.
 2. Snap Trim: Apply in full length without splices or with minimum splices and spans exceeding 16' and attach with clips spaced no more than 18 inches on center or as required to meet structural loading requirements. Clips shall be no less than 3 inches long. No exposed screws will be allowed on interior trim.

2.06 ALUMINUM WINDOW FINISHES

- A. Provide Class I, Color Anodized finish to all exposed areas of aluminum windows. Finish shall meet AAMA 611.
 1. Color: Dark bronze.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Existing Construction:
 1. Do not remove existing glass block until new replacements are available and ready for immediate installation. Do not leave any openings uncovered at end of working day, during wind-driven precipitation or during excessively cold weather.
 2. Remove existing work carefully; avoid damage to existing work to remain.
- B. Perform operations as necessary to prepare openings for proper installation and operation of new retrofit units or new construction units.
- C. Verify openings are in accordance with shop drawings and Architects Drawings.

3.02 INSTALLATION

- A. Comply with manufacturer's specifications and recommendations for installation of window units, hardware, operators and other components of work. In no case shall attachment to structure or to components of the window system be through or affect the thermal barriers of the window units.
- B. Set units plumb, level and true to line, without warp or rack of frames or sash. Anchor securely in place. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action.
- C. Wedge fiberglass insulation between frames of new windows and construction to remain, or between frames and new receptor as applicable. Compress fiberglass to no less than 50 percent of original thickness.
- D. Set sill members and other members in bed of sealant, or with joint fillers or gaskets as shown, to provide weathertight construction. Seal perimeter of units following installation and as required to provide weathertight system.

3.03 ADJUST AND CLEAN

- A. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and moving parts.
- B. Clean glass promptly after installation of windows. Remove glazing and sealant compound, dirt and other substances.
- C. Existing windows and other materials removed from site become property of the Contractor who shall promptly remove same and legally dispose of at no additional cost to the Owner.

1. Comply with all applicable laws, rules and regulations.

3.04 PROTECTION

- A. Initiate all protection and other precautions required to ensure that window units will be without damage or deterioration (other than normal weathering) at time of acceptance.

END OF SECTION

SECTION 101423 PANEL SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Panel signage.

1.02 REFERENCE STANDARDS

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

1.03 SUBMITTALS

- A. See Section 013300 - Submittals and Shop Drawings, for submittal procedures.
- B. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.
- C. Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
- D. Selection Samples: Where colors, materials, and finishes are not specified, submit two sets of color selection charts or chips.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.
- C. Store tape adhesive at normal room temperature.

1.06 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
- B. Maintain minimum ambient temperature during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Panel Signage:
 - 1. Best Sign Systems, Inc: www.bestsigns.com/#sle.
 - 2. Inpro Corporation: www.inprocorp.com/#sle.
 - 3. Seton Identification Products: www.seton.com/aec/#sle.
 - 4. Signage Innovations.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

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

2.03 PANEL SIGNAGE

- A. Panel Signage:
 - 1. Application: Room and door signs. Provide sign for all rooms indicated on the drawings that are within the scope of this project.
 - 2. Description: Flat signs with applied character panel media, tactile characters.
 - 3. Sign Size:

- a. Restroom Signs: 6 x 8 inches.
 - b. All other Signs: 2 x 6 inches.
4. Total Thickness: 1/8 inch.
5. Sign Edges: Squared.
6. Letter Edges: Squared.
7. Corners: Squared.
8. Color and Font, unless otherwise indicated:
 - a. Character Font: Arial.
 - b. Character Case: Upper case only.
 - c. Background Color: As selected by Architect from full range of available colors.
 - d. Character Color: Contrasting color.
9. Material: Acrylic plastic base with applied plastic letters and braille.
10. Tactile Letters: Raised 1/32 inch minimum.
11. Braille: Grade II, ADA-compliant.

2.04 SIGNAGE APPLICATIONS

- A. Room and Door Signs:
 1. Office Doors: Identify with the room numbers indicated on drawings.
 2. Conference and Meeting Rooms: Identify with the room numbers indicated on drawings.
 3. Service Rooms: Identify with room names and numbers indicated on drawings.
 4. Rest Rooms: Identify with pictograms, the names "MEN" or "WOMEN", and braille. If restroom is unisex, provide unisex pictogram and the word "RESTROOM" and braille.

2.05 ACCESSORIES

- A. Tape Adhesive: Double-sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with horizontal edges level.
- C. Accessibility: Install signs in locations on walls on latch side of door unless otherwise indicated at 60 inches from center of sign to finish floor.
- D. Protect from damage until Substantial Completion; repair or replace damaged items.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Control dampers.
 - 3. Fire dampers.
 - 4. Flange connectors.
 - 5. Turning vanes.
 - 6. Duct-mounted access doors.
 - 7. Flexible ducts.
 - 8. Flexible connectors.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - 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.

1.04 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.
- B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 25 percent of amount installed.

PART 2 PRODUCTS

2.01 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.

2.02 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance; a division of MESTEK, Inc.
 - b. Aire Technologies.
 - c. American Warming and Ventilating; a Mestek Architectural Group company.
 - d. Arrow United Industries.
 - e. Cesco Products; a division of MESTEK, Inc.
 - f. Greenheck Fan Corporation.
 - g. Lloyd Industries, Inc.
 - h. McGill AirFlow LLC.
 - i. Nailor Industries Inc.
 - j. Pottorff.
 - k. Ruskin Company.
 - l. Safe Air - Dowco Products.
 - m. United Enertech.
 - n. Vent Products Co., Inc.
 - 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 4. 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.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; 16 gauge thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Molded synthetic.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 - 8. Tie Bars and Brackets: Galvanized steel.
 - 9. Locking device to hold damper blades in a fixed position without vibration.
- B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. Arrow United Industries.
 - c. Cesco Products; a division of MESTEK, Inc.
 - d. Lloyd Industries, Inc.
 - e. McGill AirFlow LLC.
 - f. Nailor Industries Inc.
 - g. Pottorff.
 - h. Ruskin Company.
 - i. Safe Air - Dowco Products.
 - j. United Enertech.
 - k. Vent Products Co., Inc.
2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
4. Frames:
 - a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
 - b. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: [Galvanized steel] [Stainless steel] [Nonferrous metal].
7. Bearings:
 - a. Molded synthetic.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Aluminum.
9. Locking device to hold damper blades in a fixed position without vibration.
- C. Jackshaft:
 1. Size: 1-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.
- D. 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.

2.03 CONTROL DAMPERS (See section 230923.12)**2.04 FIRE DAMPERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance; a division of MESTEK, Inc.
 - 2. Aire Technologies.
 - 3. Arrow United Industries.
 - 4. Cesco Products; a division of MESTEK, Inc.
 - 5. CL WARD & Family Inc.
 - 6. Greenheck Fan Corporation.
 - 7. NCA Manufacturing, Inc.
 - 8. Pottorff.
 - 9. Prefco.
 - 10. Ruskin Company.
 - 11. Safe Air - Dowco Products.
 - 12. United Enertech.
 - 13. Vent Products Co., Inc.
- B. Type: Static; rated and labeled in accordance with UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.
- D. Fire Rating: Match wall.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed galvanized sheet steel, interlocking. Material gauge is to be in accordance with UL listing.
- I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
- J. Heat-Responsive Device:
 - 1. Replaceable, 212 deg F rated, fusible links.

2.05 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CL WARD & Family Inc.
 - 2. Ductmate Industries, Inc.
 - 3. DynAir; a Carlisle Company.
 - 4. Elgen Manufacturing.
 - 5. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gauge and Shape: Match connecting ductwork.

2.06 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aero-Dyne Sound Control Co.
 - 2. CL WARD & Family Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Duro Dyne Inc.
 - 5. DynAir; a Carlisle Company.

- 6. Elgen Manufacturing.
- 7. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- D. Vane Construction:
 - 1. Single wall.

2.07 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aire Technologies.
 - 2. Arrow United Industries.
 - 3. Cesco Products; a division of MESTEK, Inc.
 - 4. CL WARD & Family Inc.
 - 5. Ductmate Industries, Inc.
 - 6. Duro Dyne Inc.
 - 7. Elgen Manufacturing.
 - 8. Flexmaster U.S.A., Inc.
 - 9. McGill AirFlow LLC.
 - 10. Ruskin Company.
 - 11. United Enertech.
 - 12. Ventfabrics, Inc.
 - 13. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. 24-gauge- thick galvanized steel door panel.
 - d. Vision panel.
 - e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - f. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum frame.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.08 FLEXIBLE DUCTS

UL 181 defines two categories of flexible ducts. Ducts listed according to UL 181 must pass all UL 181 tests. Air connectors listed according to UL 181 must pass most, but not all, UL 181 tests and are limited to lengths of 14 feet (4.3 m) or less. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain first paragraph and list of manufacturers below. See Division 01 Section "Product Requirements." Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

Retain one of first five paragraphs below for noninsulated, flexible ducts. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

Retain one of first five paragraphs below for insulated, flexible ducts. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

LEED-NC Prerequisite EA 2 requires that duct insulation R-value comply with ASHRAE/IESNA 90.1-2004 tables titled "Minimum Duct Insulation R-Value, Cooling and Heating Only Supply Ducts and Return Ducts" and "Minimum Duct Insulation R-Value, Combined Heating and Cooling Supply Ducts and Return Ducts." Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.09 FLEXIBLE CONNECTORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. DynAir; a Carlisle Company.
5. Elgen Manufacturing.
6. Ventfabrics, Inc.
7. Ward Industries; a brand of Hart & Cooley, Inc.

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.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- C. 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.
- D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
- 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.

PART 3 EXECUTION

3.01 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 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.
- 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 dampers in accordance with UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. 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.
 - 2. At each change in direction and at maximum 50-ft. spacing.
 - 3. Upstream from turning vanes.
 - 4. Upstream or downstream from duct silencers.
- J. Install access doors with swing against duct static pressure.
- K. 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.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Install duct test holes where required for testing and balancing purposes.
- P. 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.

3.02 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. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.

END OF SECTION

SECTION 235216 - CONDENSING BOILERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 1. Floor-mounted, forced-draft, fire-tube condensing boilers.
 2. Condensate-neutralization units.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 1. Include plans, elevations, sections, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Product Certificates:
 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.05 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Floor-Mounted Fire-Tube Condensing Boilers:
 - a. Heat Exchanger and Tank: Free from defects in material and workmanship.
 - b. Warranty Coverage: 10 years.

PART 2 PRODUCTS

2.01 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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency in accordance with Table 6.8.1-6 and other requirements in Ch. 6 of ASHRAE/IES 90.1.
- D. Mounting Base: For securing boiler to concrete base.

2.02 FLOOR-MOUNTED, FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AERCO; A WATTS Brand.
 - 2. Cleaver-Brooks.
 - 3. Fulton Boiler Works, Inc.
 - 4. IBC Technologies; a Rheem brand.
 - 5. Laars Heating Systems Company; a subsidiary of Bradford White Corporation.
 - 6. Lochinvar, LLC.
 - 7. Raypak; a Rheem brand.
 - 8. Riello Boilers
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.
- C. Primary Heat Exchanger: Corrosion-resistant Type 316 stainless steel .
- D. Combustion Chamber and Flue Pipes: Corrosion-resistant stainless steel.
- E. Pressure Vessel: Carbon steel with welded heads and tube connections.
- F. Burner: Natural gas, forced draft.
- G. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 - a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.
- H. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- I. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- J. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Baked-enamel protective finish.
 - 4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
- K. Capacities and Characteristics:
 - 1. See schedule on plans.

2.03 TRIM - FOR HOT-WATER BOILERS

- A. Safety Relief Valve: ASME rated.
- B. Pressure and Temperature Gauge: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- C. High and low gas-pressure switches.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Circulation Pump: Nonoverloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

- G. Combustion Optimization: Oxygen trim to adjust fuel/air ratio via 3 independent methods (air damper, gas damper, and fan sped). System shall utilize feed forward information, learned trim, and feedback information. Oxygen sensor shall be located in combustion chamber. Adjustments shall be in real time during operation, continuous throughout entire modulation range, and be displayed via a gauge on the boiler touchscreen.

2.04 CONTROLS

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and P&ID's.
- B. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm.
 - b. Control: On/off operation, hot-water-supply temperature set-point adjustment.
 - 2. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. All monitoring and control features, which are available at the local boiler control panel, shall also be available at the remote operator workstation through the building automation system.

2.05 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to nonfused disconnect switch.
 - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 6. Provide each motor with overcurrent protection.

2.06 CONDENSATE-NEUTRALIZATION UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Crest
 - 2. Neutra-Safe Corporation.
 - 3. SFA Saniflo USA.
 - 4. Skidmore Pump.
 - 5. Wessels Company.
- B. Description: Factory-fabricated and -assembled condensate-neutralizing capsule tank assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.
- C. Capsule features:
 - 1. All corrosion-resistant material.
 - 2. Suitable for use on all natural gas and propane boilers.
 - 3. Includes initial charge of neutralizing agent.
 - 4. Neutralizing agent to be easily replaceable when exhausted.
 - 5. Inlet and outlet pipe connections.
- D. Capsule Configuration:

1. Low-profile design for applications where boiler condensate drain is close to the floor.
2. Easily removed and opened for neutralizing agent replacement.
3. Multiple units may be used for larger capacity.

2.07 SOURCE QUALITY CONTROL

- A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- C. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.
- D. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- E. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A. Equipment Mounting:
 1. Install floor-mounted boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.03 PIPING CONNECTIONS

- A. Comply with requirements for hydronic piping specified in Section 232113 "Hydronic Piping."
- B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.
- E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

- F. Install condensate piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.
- G. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- H. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve, and union or flange at each connection.
- I. Install piping from safety relief valves to nearest floor drain.

3.04 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with 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 with a black background and engraved white letters at least 1/2 inch high.

3.05 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.06 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:
 - 1. Perform installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Boiler will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.
 - 1. Instructor shall be factory trained and certified.
 - 2. Provide not less than two hours of training at project site.
 - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 5. Obtain Owner sign-off that training is complete.

END OF SECTION

SECTION 236433 - MODULAR WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Modular Variable Speed Scroll Chillers.
- B. Controls and Control Connections.

1.02 REFERENCES

- A. AHRI 550/590-2011 - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle.
- B. AHRI 700-2012 - Specification for Fluorocarbon Refrigerants.
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ANSI/ASHRAE 135 - BACnet-2001.
- F. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code.
- G. ANSI/NEMA MG 1 - Motors and Generators.
- H. ANSI/NFPA 70 - National Electric Code.
- I. ANSI/UL 1995 - Heating and Cooling Equipment.
- J. International Mechanical Code - 2012 - Chapter 11: Refrigeration.

1.03 SUBMITTALS

- A. Submit shop drawings per Section 230500, indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, piping and connections, valves, strainers, and thermostatic valves required for complete system, rated and certified capacities, specialties and accessories, electrical requirements, and electrical power/controls wiring diagrams.
- B. Submit manufacturer's installation instructions, quality control test reports including sound power data by octave band, startup service reports, and warranty.
- C. Submit AHRI certified performance data indicating IPLV at AHRI conditions.
- D. Submit list of points communicated via BACnet IP interface. Indicate which points are read-only and read-write.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation. Protect insulation during construction from dust, debris, and/or damage.
- C. Unit controls shall be capable of withstanding 150°F storage temperatures indefinitely.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation data, startup instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide. Operation data shall include emergency, operation, and maintenance manuals.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of the products specified in this Section, with minimum five (5) years' experience.
- B. All manufacturers shall have factory authorized and trained service personnel within 180 miles of the project site.

1.07 WARRANTY

- A. Provide one (1) year parts and labor warranty from startup date. Include coverage for complete modular chiller package as manufactured and delivered to site, including materials, labor, seals, and replacement refrigerant.
- B. Provide five (5) year compressor warranty.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- B. Multistack
- C. Trane
- D. WaterFurnace
- E. ClimaCool

2.02 MODULAR CHILLER PACKAGE

- A. Provide factory assembled and tested, packaged, modular water-cooled chiller consisting of multiple modules of sizes as scheduled. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits or changeout of one or more modules.
- B. The modular chiller shall control to a chilled water temperature. This occurs by staging the modules to meet the chilled water temperature setpoint and modulating chilled water flow to meet the chilled water temperature setpoint. Leaving chilled water is allowed to float based on cooling demand.
- C. Each module shall be self-contained including variable speed scroll compressors, motors, condenser, evaporator, control valves, refrigeration accessories, control panel auxiliary components, interconnecting piping and wiring, accessories, and motor starters.
- D. Each module shall consist of no less than two refrigeration circuits. Each circuit shall be constructed to be able to operate independently. Failure of a single circuit shall not affect other circuits.
- E. Each independent refrigerant circuit shall consist of the following:
 - 1. Compressor
 - 2. Sight glass
 - 3. Replaceable filter drier with charging connection
 - 4. High and low pressure and/or low temperature safety controls
 - 5. Refrigerant receivers
 - 6. Reversing valve
- F. All modular chiller components, including compressor, motor, condenser, evaporator, refrigeration accessories, control panel auxiliary components, interconnecting piping and wiring, accessories, and motor starters, shall be mounted on a heavy steel frame. All electrical controls shall be contained in the same module.
- G. Each bank of modules shall be provided with a common control system that shall be capable of staging the operation of the units to simultaneously maintain the leaving evaporator and condenser temperatures as scheduled. Refer to the control drawings for details of the control sequence.
- H. Units shall have efficiency meeting ASHRAE 90.1.
- I. Unit performance shall be as listed on the drawings.
- J. Factory insulate all cold surfaces of unit with minimum 1/2" closed cell flexible elastomeric insulation with maximum 'K' value of 0.26.

- K. Unit shall be factory pressure tested and fully charged and run tested at scheduled evaporator and condenser water flow rates.
- L. Provide automatic control valves in evaporator and condenser piping of each module to provide isolation of modules during part load operation.

2.03 VARIABLE SPEED SCROLL COMPRESSORS

- A. Each module shall contain two scroll type hermetic compressors independently circuited with rubber-in-shear isolators. Lead variable speed compressor with permanent magnet motor and built-in intermediate discharge valves that adapt the effort of the motor and its energy consumption to varying load. Each system shall also include high discharge pressure and low suction pressure manual reset safety cutouts.
- B. Refrigerant: Charge unit with R-454B refrigerant and POE or PVE oil at the factory and provide field charging if required after installation. Each circuit shall require no more than 16 lbs of refrigerant. Suction gas cooled motors operate at 3500 rpm protected by internal overload device.
- C. Acoustically insulated sound blanket are factory installed around the compressor to reduce sound emanating from the compressor.
- D. Oil Management: Built-in oil management and three stage oil separate system.

2.04 EVAPORATOR

- A. Brazed plate heat exchanger, seamless or welded 316 stainless steel plate construction with copper brazing, designed for 650 psig working pressure.
- B. Insulate evaporator and suction side refrigerant tubing with minimum 3/4" closed cell insulation blanket to prevent condensation.
- C. Construction and materials per ANSI B9.1 and ANSI/ASME SEC 8.

2.05 CONDENSER

- A. Brazed plate heat exchanger, seamless or welded 316 stainless steel plate construction with copper brazing, designed for 650 psig working pressure.
- B. Construction and materials per ANSI/ASME SEC 8.
- C. Provide with taps for refrigerant safety relief valve.

2.06 EVAPORATOR AND CONDENSER WATER MAINS

- A. Each module shall include supply and return mains for both evaporator and condenser water.
- B. Supply and return mains shall be provided separately from chiller modules.
- C. End connections between units and for piping connection shall be grooved and shall be compatible with 6 inch standard piping.

2.07 CONTROLS

- A. Parent Controller: Parent controller shall be capable of monitoring and staging each bank of modular chillers. System shall have a remote parent controller.
- B. The unit shall have the capability to operate in response to cooling water setpoints.
- C. A new lead compressor is selected every 24 hours to assure even distribution of compressor run time. LIFO or FIFO shall be selectable based on Owner preference.
- D. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freezing up.
- E. The unit control system shall monitor entering and leaving chilled water and condenser water temperatures to determine system load and select the number of compressor circuits required to operate to satisfy the building load.
- F. Provide all interface hardware and software required for an interface connection to the BMS. Provide all hardware and software definitions involved with the interface. Provide a chiller service technician to assist with commissioning of the controls. Provide interface for the following points:
 - 1. Analog Inputs to DDC:
 - a. Entering chilled temperature.

- b. Leaving chilled temperatures.
 - c. Entering condenser water temperature.
 - d. Leaving condenser water temperature.
 - e. Compressor run time.
 - f. Suction temperature.
 - g. Chilled water flow status.
- 2. Analog Outputs from DDC:
 - a. Chilled water setpoint.
- 3. Binary Inputs to DDC:
 - a. Chiller run status.
 - b. Manual reset alarms.
 - c. Auto reset alarms.
 - d. Low water flow.
 - e. Low water temperature.
 - f. Compressor status.
 - g. Discharge pressure fault.
 - h. Suction pressure fault.
- 4. Binary Outputs from DDC:
 - a. Chiller Enable/Disable.
- G. Provide the following safety controls arranged so that operating any one will shut down the affected module and require manual reset:
 - 1. High refrigerant (condenser) pressure.
 - 2. Low refrigerant (evaporator) temperature and pressure for R-454B..
 - 3. Low leaving evaporator temperature.
- H. Provide with the unit the following safety controls factory installed, arranged so that operating any one will shut down machine and automatically reset:
 - 1. Chilled water flow switch (differential pressure or thermal dispersion type).
 - 2. Condenser water flow switch (differential pressure or thermal dispersion type).
- I. Provide the following functions from the control panel face:
 - 1. Machine off-auto switch.
 - 2. Selector switch for load, unload, hold, or automatic operation.
 - 3. Operating/alarm condition.
 - 4. Temperature and pressure operating setpoints.
 - 5. Entering and leaving temperatures of chilled water and condenser water.
 - 6. Refrigerant pressures in evaporator and condenser.
 - 7. Evaporator low temperature cutout condition.
 - 8. Condenser high pressure cutout condition.
 - 9. Electronic overload provides overload protection, protects compressor motor from distribution system irregularities, and provides motor current signal to chiller capacity control module.
 - 10. Number of compressor starts.
- J. Equipment manufacturer factory authorized service agent shall be responsible for assisting the Temperature Control Contractor and the temperature control programmer with device addressing and confirming that the unit communicates with the FMCS as specified. Reset the unit specific BACnet and internet protocol addresses to coordinate with Owner/Agent. Owner/Agent shall be on site to provide the assistance; remote assistance is not acceptable.
- K. Unit controls shall provide the monitoring and control points available to the FMCS system as described on the control drawings. The FMCS system will provide monitoring, setpoint adjustment, and scheduling of units.

2.08 ELECTRICAL POWER REQUIREMENTS

- A. Each chiller module shall have power connections as scheduled.
- B. Provide steel NEMA 1 type enclosure mounted on chiller. Enclosure size shall meet NEC requirements for termination of number and size of wires shown on electrical plans.
- C. Enclosure shall be designed for top or bottom cable entry with front access. Door shall accommodate padlock.
- D. Provide panel enclosures made of 18 gauge sheet metal with powder coat paint finish and fiberglass insulation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Field insulate piping and mechanical couplings used in joining chilled water, and condenser water headers together within chiller enclosure in accordance with the requirements of Section 230716. Pipe insulation and jacket types shall match those called for in Section 230719.
- C. Coordinate with Electrical Contractor for connection(s) to electrical service.
- D. Install unit on rails and isolation pad as recommended by manufacturer.
- E. Align modules on rails or pad and install coupling gaskets between modules.
- F. Install top and bottom joining bolts between modules. Install header blank ends.
- G. Install enclosure panels, if provided separately.
- H. Provide connections to chilled water piping. On inlet, provide, thermometer and well, 30-mesh strainer flexible connector, pressure gauge, port for differential pressure sensor or flow switch and shutoff valve. On outlet, provide, thermometer and well, flexible connector, pressure gauge, port for differential pressure sensor or flow switch and balancing valve., Provide full size bypass and shutoff valve to be used to bypass equipment during chemical treatment at startup and flushing.
- I. Provide connections to condenser water piping. On inlet, provide, thermometer and well, 30-mesh strainer flexible connector, pressure gauge, port for differential pressure sensor and shutoff valve. On outlet, provide, thermometer and well, flexible connector, pressure gauge, port for differential pressure sensor and shutoff valve. Provide full size bypass and isolation valve to be used to bypass equipment during chemical treatment at startup and flushing.
- J. For variable flow chillers, install bypass with control valve to prevent dead-heading of pumps. Locate bypass in piping system per manufacturer's recommendations.
- K. Arrange piping for easy dismantling for tube cleaning.
- L. Manufacturer shall work with the Contractor to ensure proper installation.
- M. If parent controller is remote from modules, install control wiring between controller and modules. Install 120V power connection for parent controller.
- N. Install and wire chiller differential pressure sensors, if furnished loose by manufacturer. These are separate from the differential pressure sensors required for the FMCS.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems.
- B. Provide services of factory authorized and trained representative to leak test, refrigerant pressure test, startup, and calibrate controls. Provide separate 8-hour day to instruct Owner on operation and maintenance.
- C. Supply initial charge of refrigerant and oil as required to completely fill the system.
- D. For field installed VFDs, the manufacturer shall perform an electrical and mechanical test at startup to verify the system is properly wired and operational.

3.03 MANUFACTURER'S FIELD COMMISSIONING SERVICES

- A. Chiller manufacturer factory authorized and trained representative, Temperature Control Contractor, Mechanical Contractor, and Engineer shall meet on site for four non-consecutive days for initial startup, commissioning, and troubleshooting: two days shall be for heating season setup, and two days shall be for cooling season setup.
- B. Manufacturer shall take water sample from evaporator and condenser sides and perform analysis to ensure that the water meets the requirements of the heat exchanger manufacturer.

3.04 DEMONSTRATION

- A. Demonstrate system operation and verify specified performance.

3.05 OWNER TRAINING REQUIREMENTS

- A. Provide three non-consecutive days of on-site training to take place before and during the course of the first year of operation.
- B. Provide factory training for two days for up to four Owner's representatives.

END OF SECTION 236433

SECTION 236514.14 - COOLING TOWERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes factory-assembled, open-circuit, induced-draft, crossflow cooling towers.

1.03 DEFINITIONS

- A. SCCR: Short-circuit current rating.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
 2. Maximum flow rate.
 3. Minimum flow rate.
 4. Pressure required at cooling tower supply piping connections.
 5. Drift loss as percent of design flow rate.
 6. Sound:
 - a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
 - b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.
 7. Performance curves for the following:
 - a. Varying entering-water temperatures from design to minimum in one -degree temperature increments.
 - b. Varying ambient wet-bulb temperatures from design to minimum in one -degree temperature increments.
 - c. Varying water flow rates from design to minimum in increments of 10 percent of flow rate difference between design and minimum flow rates.
 - d. Varying fan operation from design to minimum speed in 10 percent speed increments, and with fan off.
 8. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
 9. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
 10. Electrical power requirements for each cooling tower component requiring power.
- B. Shop Drawings:
 1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
 2. Assembled unit dimensions.
 3. Diagram showing each separate piece requiring field assembly.
 4. Shipped sub-assembly dimensions and weights for field assembly.
 5. Assembled unit weight without water.
 6. Operating weight and load distribution.

7. Unit vibration isolation.
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 1. Drawings on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Structural supports.
 - b. Piping roughing-in requirements.
 - c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
 - d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances on drawings.
- B. Product Certificates: For certification required in "Quality Assurance" Article.
- C. Source quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts:
 1. Furnish one set(s) of matching belts for each unique belt configuration and size furnished.

1.08 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by CTI.
- B. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.
- B. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
 1. All components of cooling tower.
 2. Insert components requiring extended warranty.
 3. Warranty Period: 1 year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Baltimore Aircoil Company.
 2. EVAPCO, Inc.
 3. Marley Cooling Technologies; SPX Cooling Technologies.

2.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 .
- B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Vibration:
 - 1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
 - 2. Critical speed shall be at least 115 percent of design speed.

2.03 DESIGN ARRANGEMENT

- A. Crossflow design with airflow from one side and induced-draft, side-mounted axial fan and gravity distribution basin.

2.04 CASING AND FRAME

- A. Casing Material: Galvanized steel, ASTM A 653/A 653M, G235 coating.
- B. Frame Material: galvanized steel, ASTM A 653/A 653M, G235 coating.
- C. Hardware: Galvanized or stainless steel.
- D. Joints and Seams: Sealed watertight.
- E. Welded Connections: Sealed watertight.

2.05 COLLECTION BASIN

- A. Factory-Assembled Collection Basin:
 - 1. Material: Stainless steel, Grade 301L.
 - 2. Hardware: Galvanized or stainless steel.
 - 3. Joints and Seams: Sealed watertight.
 - 4. Welded Connections: Sealed watertight.
 - 5. Removable stainless-steel strainer with openings smaller than nozzle orifices.
 - 6. Overflow and drain connections.
 - 7. Makeup-water connection.
 - 8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.

2.06 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

- A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve
 - 1. Enclosures: NEMA 250, Type 4.
 - 2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to control makeup-water valve and low- and high-level alarms.
 - 3. Electrode Probes: Stainless steel.
 - 4. Makeup-Water Valve:
 - a. Slow closing with stainless-steel body.
 - b. Actuator controlled and powered through level controller in response to water-level set point.
 - c. Actuator Enclosure: NEMA 250, Type 4.
 - d. Fail Position: Open.
 - e. Action: Two position.
 - 5. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.07 COLLECTION BASIN HEATER

- A. Electric Heater:
 - 1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.

2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 4.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except connections to each electric basin heater shall be liquidtight conduit.

2.08 GRAVITY WATER DISTRIBUTION BASIN

- A. Design: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
 1. Material: 301L stainless steel.
 2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
 3. Inlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
 4. Fasteners: Galvanized or stainless steel.
 5. Joints and Seams: Sealed watertight.
 6. Welded Connections: Sealed watertight.

2.09 FILL, LOUVERS, AND DRIFT ELIMINATOR

- A. Materials: 15 mil PVC, with maximum flame-spread index of 25 according to ASTM E 84.
- B. Fabrication: Fill-type sheets with louvers and drift eliminator formed as part of each fill sheet, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer, suspended from hot dip galvanized structural tubing supported from the upper tower structure, and shall be elevated above the floor of the cold-water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash-out. Guaranteed drift losses shall not exceed 0.005% of the design GPM.
- C. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 125 deg F.
- D. Hardware: Galvanized or stainless steel.

2.10 AIR INLET

- A. Removable Air-Intake Screens:
 1. Galvanized -steel wire mesh with openings of size sufficient to not restrict airflow or impact performance.
 2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.
- B. Hardware: Galvanized or stainless steel.

2.11 FAN AND DRIVE ASSEMBLY

- A. Axial Fan: Balanced at the factory after assembly.
 1. Blade Material: Fiberglass reinforced polypropylene, Aluminum, or galvanized steel.
 2. Hub Material: Aluminum or galvanized steel.
 3. Fan Shaft: Corrosion resistant.
 4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 40,000 hours.
 5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

- B. Belt Drive:
 - 1. Service Factor: 1.5 based on motor nameplate horsepower.
 - 2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
 - 3. Belt: One-piece, "B" cross-section V-belt.
 - 4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
 - 5. Belt-Drive Guard: Comply with OSHA regulations.
- C. Fan Motor:
 - 1. Comply with NEMA MG 1 unless otherwise indicated.
 - 2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
 - 3. 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.
 - 4. Motor Enclosure: Totally enclosed fan-cooled (TEFC).
 - 5. Rotor: Random-wound, squirrel cage.
 - 6. Energy Efficiency: Comply with ASHRAE/IES 90.1.
 - 7. Service Factor: 1.15.
 - 8. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
 - 9. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
- D. Hardware: Galvanized or stainless steel.

2.12 ELECTRIC IMMERSION BASIN HEATER

- A. Provide a system of electric immersion heaters and controls for each cell of the tower to prevent freezing of water in the collection basin during periods of shutdown. The system shall consist of one or more stainless steel electric immersion heaters installed in threaded couplings provided in the side of the basin. A NEMA 4 control panel and associated temperature probe shall include circuitry to monitor cold water temperature and low water level, providing ON/OFF thermostatic like control. The temperature probe shall be located in the cold-water basin. The system shall be capable of maintaining 40°F water temperature at an ambient air temperature of -20°F

2.13 SERVICE ACCESS

- A. Service access shall be thru the air inlet and discharge by removing the 2-piece inlet screen or fan guard outlet screen.
- B. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.14 SOURCE QUALITY CONTROL

- A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."
 - 1. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- B. Factory Functional Tests:
 - 1. Test collection and distribution basins after assembly, and prove free of leaks.
 - 2. Test factory-installed electric/electronic water-level controls for proper operation.
 - 3. Test factory-installed electric basin heaters for proper operation.
 - 4. Test factory-installed fan and drive assemblies for proper operation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine cooling towers before installation. Reject cooling towers that are damaged.
- B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.
 - 1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
 - 2. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install cooling towers on support structure.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Maintain clearances required by governing code.
- F. Loose Components: Install components, devices and accessories furnished by manufacturer, with cooling tower, that are not factory mounted.
 - 1. Loose components shall be installed by manufacturer's factory-trained service personnel.

3.03 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 cooling towers, allow space for service and maintenance.
- C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.
- D. Install drain piping with valve at cooling tower drain connections and at low points in piping.
- E. Connect cooling tower overflows and drains, and piping drains, to sanitary sewage system.
- F. Makeup-Water Piping:
 - 1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
 - 2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, flow meter, and drain connection with valve and union.
- G. Supply and Return Piping:
 - 1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 - 2. Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
 - 3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
 - 4. Make connections to cooling tower with a flange.

3.04 ELECTRICAL POWER CONNECTIONS

- A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

- C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.
- D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.05 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.
- C. Connect control wiring between cooling tower control interface and control system for HVAC for remote monitoring and control of cooling towers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identifying products and installations.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections: Comply with CTI ATC 105.
- C. Cooling towers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.07 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.
- C. Obtain performance data from manufacturer.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Clean entire unit including basins.
 - b. Verify that accessories are properly installed.
 - c. Verify clearances for airflow and for cooling tower servicing.
 - d. Check for vibration isolation and structural support.
 - e. Lubricate bearings.
 - f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
 - g. Adjust belts to proper alignment and tension.
 - h. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
 - i. Verify operation of basin heater and control.
 - j. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
 - k. Replace defective and malfunctioning units.
- D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
- E. Prepare a written startup report that records the results of tests and inspections.

3.08 ADJUSTING

- A. Set and balance water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.
- C. Adjust basin heater control for proper operating set point.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.
 - 1. Video record the training sessions.
 - 2. Instructor shall be factory trained and certified.
 - 3. Perform not less than Insert value 1 hour of training.
 - 4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 5. Perform instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 6. Obtain Owner sign-off that training is complete.
 - 7. Owner training shall be held at Project site.

END OF SECTION