HEATING, VENTILATING AND AIR CONDITIONING CONSTRUCTION SPECIFICATION

DIVISION 230000 – MECHANICAL SYSTEMS SPECIFICATION INDEX

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HEATING, VENTILATING AND AIR CONDITIONING CONSTRUCTION SPECIFICATION

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 INTENT/SCOPE

A. It is the intent of this specification and accompanying drawings to describe and indicate the manufacture, erection and installation of the equipment and connection to the same specified herein and shown on the drawings. It is not intended that the specifications and drawings describe and indicate each piece of equipment required for installation, for where items are intended or required for a satisfactory installation and are the accepted practice of the trade, they shall be considered to be both specified and indicated.

B. This Specification and the Contract Drawings are intended to be utilized by the HVAC Contractor to install certain heating, ventilating and air conditioning equipment, but are not to be interpreted to contain certain basic system installation knowledge essential for a complete and quality installation. By providing a bid to the Prime General Contractor, this HVAC Contractor is certifying that he/she has experience in installations of HVAC systems of comparable size and possesses knowledge and employs knowledgeable personnel to ensure the HVAC installation is complete in all respects.

C. The terms "The Contractor", "This Contractor", “HVAC Contractor” or "Heating Contractor" mentioned in these Specifications refers to the HVAC Contractor responsible for the installation in its entirety.

D. Due to the small scale of the drawings, all required offsets and fittings may not be shown but shall be provided at no change in the contract price.

E. As many of the lines as could practically be shown on the drawings have been identified, but some have been omitted for clarity. The Contractor shall furnish and install all such piping and/or ductwork that may be required or directed to effect proper connections to all apparatus, equipment, and fixtures in accordance with the manufacturer’s detailed drawings and instructions.

F. The Contractor shall schedule and coordinate all work in close cooperation with all trades working on this project.

G. Work and materials are to be installed subject to the approval of the Architect and the Owner.

H. Where the word "Architect" appears in this Specification, it means Engineer and Owner.

I. The Contractor is to carefully examine the site, Plans and Specifications and include labor and equipment necessary to perform, but not necessarily limited to, the following work:

   1. Demolition of the existing Roof Mounted Air Handling Units and glycol circulation pumps for direct replacement.
2. Furnish and install new Roof Mounted Air Handling Units to directly replace the existing AHUs. The new AHUs will be complete with hot water heating coils, chilled water coils, supply air fans, MERV 13 filters, air stream UVGI lights and have new controls tied into the campus ATC system.

3. Furnish and install new glycol circulation pumps to replace the existing. The new pumps will be inline circulators and the supply and return piping feeding each pump will need modified from the current orientation feeding the existing base-mounted pumps.

4. Under Add-Alternate H-1 replace all existing pneumatically controlled VAV terminals with new electrically controlled VAVs.

5. All other miscellaneous work shown on the Drawings and as herein specified.

6. **IMPORTANT NOTE:** Because this is a single prime contract with the HVAC Contractor as the Prime, designation in this specification to the responsibilities of any of the Sub-Contractors is for clarification only – ALL work shown on the Drawings and herein specified is ultimately the responsibility of the Prime Contractor.

J. The requirements of this Section apply to all sections of Division 23.

1.2 RELATED REQUIREMENTS/SECTIONS

A. The specifications sections "General Conditions", "Special Conditions" and "General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 019113 - General Commissioning Requirements.

1.3 REFERENCE STANDARDS/APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced.

B. The publications are referenced in the text by the basic designation only. The most recently adopted version of the reference publication shall govern.

C. Where conflicts occur the more stringent version will apply.

1. NFPA National Fire Protection Association

2. UL Underwriters' Laboratories, Inc.

3. AFI Air Filter Institute

4. NEMA National Electrical Manufacturer's Association

5. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
6. ARI American Refrigeration Institute
7. AMCA Air Moving and Conditioning Association
8. ANSI American National Standards Institute
9. AGA American Gas Association
10. SMACNA Sheet Metal and Air Conditioning Contractors National Association
11. HI Hydronics Institute
12. OSHA Occupational Safety and Health Act
13. ASTM American Society for Testing and Materials
14. Association for Rubber Products Manufacturers (ARPM):
15. International Building / Residential Code
16. International Mechanical Code
17. International Plumbing Code
21. Requirements of the authority having jurisdiction, including but not limited to, amendments to the International Codes.
22. Requirements of the equipment manufacturers.

1.4 SUBMITTALS

A. General: Provide submittals in accordance with the General Conditions of the Contract and this Section.

1. Approval: Is to be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

2. All materials, appliances, machines and fixtures are to satisfy completely all the specification requirements in each case and are to be of the best available quality and grade. Equipment of equal quality with a satisfactory record of performance will be considered for review.

3. Mark submittals with applicable Project Name, Specification Section # (and paragraph if applicable) and Drawing reference/tag. Submissions are to be coordinated with the contract
Drawings and be marked and clearly labeled using tag descriptions as indicated there on. Where multiple models are indicated on the submission, the submission is to be marked up by the Contractor to indicate which model is being proposed. Unmarked, unlabeled submissions will be rejected.

4. The submittals are to be complete with necessary construction and functional details requisite for a thorough evaluation. Such items as are rejected are to be promptly resubmitted in conformity with the Specification requirements. Corrections or comments made on Shop Drawings during this review will not relieve the Contractor from compliance with requirements of the Drawings and Specifications. This check is only for review of general compliance with the information given in the Contract Documents. The Contractor is to be responsible for: confirming and correlating quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades and performing his work in a safe and satisfactory manner.

5. Submittals for individual systems and equipment assemblies, which consist of more than one item or components are to be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

6. Electronic submissions will be accepted if the submission contain less than 10 printed pages. If the submission is larger than 10 pages, one hard copy is to be sent directly to the Engineer in addition to the standard electronic delivery.

7. Deliver electronic submissions to the Architect who will forward them to Rebecca Berkey at RebeccaB@easthillseng.com and all hard copy submissions to East Hills Engineering Associates LLC, 541 Main Street, Windber, PA 15963.

8. Product Data: After award of the Contract submit:
   a. A complete list of all materials proposed to be furnished and installed under this Section. At a bare minimum the contractor is required to submit on the following prior to installation:
      1) Air and Water Balance Report
      2) Air Handling Units
      3) Automatic Temperature Controls
      4) Condensate Overflow Sensor and Alarm (if not integral to Air Handling equipment)
      5) Copies of Warranty Cards
      6) Curb Adaptors
      7) Duct Construction Methods and materials
      8) Duct Insulation
9) Duct Supports
10) Equipment Start-Up Forms
11) Letter of Certification that Instructions Have Been Given
12) Operation and Maintenance Manuals
13) Piping insulation
14) Pumps
15) Record Drawings
16) Remote Air-Cooled Condensing Units
17) Roof Equipment Rails
18) Roof Pipe Portals
19) Ultra-Violet Germicidal Irradiation Systems and Lamps
20) VAV Terminals (under Add Alternate H-1)

b. Information, which confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.

c. Manufacturers' recommended installation procedures which, when approved by the Architect, will become the basis for inspecting and accepting or rejecting actual installation procedures used on the Work.

d. Product Identification. Submittals for mechanical equipment, shall be identified by the fixture tag that is indicated on the drawings. Where a submittal includes information on multiple unit sizes, etc. the proper unit is to be marked on the submitted form.

e. Submittals on all mechanical equipment (i.e. rooftop units, unit ventilators, etc.), complete with capacities, performance curves marked with design points and all applicable engineering data.

f. Submittals on electrical equipment for mechanical equipment, complete with all power and control wiring diagrams.

g. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

B. Closeout Submittals:
1. Operation and Maintenance Data: Provide Operation and Maintenance Data in accordance with the General Conditions of the Contract, Section 01-78-00 – Close Out Submittals and per Part 3 of this Section – Operations and Maintenance Manuals.

2. Warranties and Bonds: Provide Warranties and Bonds in accordance with the General Conditions of the Contract, Section 01-78-00 – Close Out Submittals and per Part 3 of this Section – Warranties and Bonds.

3. As-Built Drawings: Provide Record Documentation (As-Built Drawings) in accordance with the General Conditions of the Contract and Section 01-78-00 – Close Out Submittals.
   a. Record Drawings During Construction: During progress of the Work, maintain a current (daily) record set of Contract Drawings and Specifications, indicating thereon work installed at variance with such Contract Documents, including work covered by supplemental contracts, addenda, change orders or other bona fide sources. All variances to the Original Contract Documents are to be indicated in red.
   b. Close out Documents: At the completion of the construction work and as a condition of its acceptance, furnish to the Architect these marked-up documents to be used by the Owner as a record of exact locations of installed systems. The marked-up Drawings may be utilized by the Architect to prepare “As-Constructed” AutoCAD Drawings.

4. Assist the Architect with compiling information specific to the energy efficient systems incorporated into the building

C. Substitutions:

1. The various materials and products specified in the Specifications by name or description are given to establish a standard of quality and of cost for bid purposes. It is not the intent to limit the acceptance to any one material or product specified but rather to name or describe a material or product as the absolute minimum standard that is desired and acceptable. A material or product of the lesser quality would not be acceptable.

2. IMPORTANT: Where a product is named by manufacturer and model number and other manufacturer's names are listed (in parentheses), those names in parentheses are considered to be substitute manufacturers whose equipment may be acceptable, provided that they meet the intent of the Specification, and meet or exceed required capacities.

3. Where only one name is stated in this Specification, only that manufacturer's equipment will be acceptable.

4. Equipment is to be installed in accordance with the manufacturer's data and recommendations.

5. Where equipment is not specified, it is intended that only first grade material be used. Only new equipment in good condition will be accepted. Equipment is subject to inspection and approval of the Engineer.
6. Items installed prior to approval by the Engineer are at the Contractor's risk. The Engineer may require non-approved items to be removed and replaced with specified items.

7. **EXTREMELY IMPORTANT:** Resubmission of items rejected or marked "Revise and Resubmit" will be reviewed one time by the Engineer at no cost to the Contractor. Should the resubmittal be rejected or marked "Revise and Resubmit", the Contractor will be invoiced for any additional time spent by the Engineer at his current billing rate.

8. The Contractor is to assume sole responsibility for structural, mechanical, and electrical changes required to accommodate substituted material or equipment.

9. Should it be shown by printed data that any substituted piece of equipment uses more energy (natural gas, electricity, etc.) than the piece of equipment upon which design was based, the substituted piece of equipment will be rejected.

### 1.5 QUALITY ASSURANCE

A. It is the intention of these documents to conform to all applicable codes, standards, regulations and guidelines as referenced. In the event that a discrepancy between the documents and governing documents occurs the Contractor is to immediately inform the Architect to obtain an interpretation and proper instructions.

B. All equipment is to meet or exceed the requirements of the Energy Efficiency Code being enforced by the Authority Having Jurisdiction.

C. Manufacturer Qualifications are indicated under the specific sections within this Division pertaining to the equipment they are to provide.

D. Contractor Qualifications: By submitting a bid to the Owner, this Contractor attests that they employ personnel with experience installing systems of similar size and scope and can provide references for at least three (3) similarly sized projects completed within the last five (5) years.

E. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Receipt of Equipment and Material

1. New equipment being used on this project, whether delivered to jobsite or to this Contractor’s place of business, is to be examined (to determine if the equipment was damaged) prior to signature of receipt by the Contractor’s representative. It is the Contractor’s responsibility to file damage claims with the mover (truck, railroad, etc.) at time of receipt of damaged equipment.

B. Protection of Equipment

1. It is to be the responsibility of the Contractor to protect equipment, piping, insulation, controls and similar items of equipment from dirt, grime, plaster and water during each
phase of construction. This protection is to be provided by covering with transparent plastic sheeting, caps or as required to the satisfaction of the Engineer.

2. Protection is to include sheds or other buildings as required for protection of materials and equipment. In the event the available areas on the site are inadequate, the Contractor is to, at his own expense, provide suitable storage under roof at other locations.

C. Storage of Material

1. The Contractor is to erect and maintain proper facilities for protecting materials and equipment furnished under this Contract during each phase of construction until acceptance by the Engineer. Any damaged materials or equipment is to be repaired or replaced by the Contractor at his own expense to the satisfaction of the Engineer and the Owner.

1.7 COMPLIANCE WITH CODES, LAWS, REGULATIONS AND STANDARDS

A. Bidders must have determined applicability, became thoroughly familiar and are required as part of this Contract to comply with local, county, state and federal codes, statutes, rules and regulations. The Contractor's work on this project must be in accordance with each statute and the cost of compliance (including inspection fees, review fees, permits, certificates and required course of work) must be included in the Contractor's bid price.

B. Comply with all local Codes. Comply with requirements of the local Authority Having Jurisdiction.

C. Work is to conform to all applicable Reference Standards as indicated above. If an above-named code has been replaced by an updated version and has been adopted by the authority having jurisdiction, the Contractor will be held responsible for complying with the same.

D. Materials and equipment under the Contract are to be new and bear the Underwriter's Laboratories label wherever a standard has been established by that agency.

1.8 INSPECTIONS, PERMITS, LICENSES AND FEES

A. Contractor at his own expense shall make any tests directed by an inspection authority or by the Owner's Representative and shall provide all equipment, instruments and materials to make such tests.

1.9 WARRANTY

A. Include the below provisions as part of the contract warranty unless more stringent provisions are included within the General Conditions.

1. The Contractor is to guarantee for a period of one (1) year from the date of final acceptance that material and workmanship furnished under the Contract are free from defects. The Contractor is to replace any equipment or material found defective within the guarantee period at no cost to the Owner.
2. The Contractor is to, during the guarantee period, be responsible for the proper adjustments of systems, equipment and apparatus installed by him and do work necessary to ensure efficient and proper functioning of the system and equipment.

3. **Warranty and Guarantee Manual:** Upon completion of this portion of the Work, and as a condition of its acceptance, provide copies of completed warranty cards that are to be sent back to equipment manufactures for all equipment with extended warranties, including all compressors, air handlers, condensing units, and etc. Include copies of these warranty cards within the above O&M Manual.

4. Manufacturers' Warranties:
   a. Refer to specific Division 23 sections for information regarding manufactured equipment warranties
   b. Where the duration of a manufacturer's standard warranty exceeds that specified, the manufacturer's warranty shall take precedence.
   c. In the event that a manufacturer's warranty expires prior to the expiration of the above contractor's guarantee, the warranty shall be extended to the end of the contractor's guarantee without additional expense to the Owner.
   d. Where the duration of the manufacturer's standard warranty is less than that specified, the manufacturer is to provide a special warranty extension as required and shall provide a certificate attesting to that extension with the equipment submittal.

**PART 2 PRODUCTS**

**2.1 VOC REGULATIONS**

A. All adhesives must comply with Rule 1168 of the South Coast Air Quality Management Districts (SCAQMD).

B. All caulks and sealants must comply with Regulations 8 Rule 51, of the Bay Area Air Quality Management District (BAAQMD).

C. All paints, primers and clear finishes used shall be low volatile organic compound (VOC) type in accordance with the following maximum VOC levels:
   1. Flats: 50g/L
   2. Non-Flats: 50g/L
   3. Floor: 100g/L

**2.2 FIRESTOP PENETRATION PROTECTION SEALING SYSTEM**

A. Where mechanical piping and ductwork pass through rated floors, walls, partitions, ceilings or roofs, the Mechanical Contractor shall provide a firestop penetration protection sealing system to
restrict the passage of fire, smoke and hot gasses. The firestop material shall provide the same fire-resistance rating as the assembly penetrated and shall be UL listed. Firestops that generate toxic smoke are not permitted.

2.3 ACCESS PANELS

A. Furnish under this Contract panels for access to concealed duct or piping accessories for maintenance. Access panels in fire rated ceiling are to be similarly rated.

B. The General Contractor is to cut openings and install the access panels in drywall ceilings. In suspended lay-in ceilings, use ceiling panel in place of access panel.

C. Provide an identification tag attached to the ceiling grid indicating the symbol shown on the Drawings for the concealed item.

D. Access panels are to be of size indicated on the Drawings and where not indicated, panels are to be 16" x 16" minimum or larger as necessary. For acoustical ceilings, conform to Architectural panel pattern.

E. Access panels are to be steel construction with 16 gauge wall or ceiling frame and No. 20 gauge panel door for fire rated units and 16 gauge frame and 14 gauge doors for other applications. Doors are to be provided with continuous concealed piano hinges. Doors on rated units are to be with cylinder lock. Except where otherwise specified, all units are to be with screwdriver operated cam and stud.

F. Fire rated panels are to be filled with 2" thick fire rated insulation.

G. Fire rated access panels are to have automatic closers. Panels are to be self-latching and contain an interior door latch. Latches are to be key type operated.

H. Fire rated panels are to have a "B" U.L. label and be wall rated for 1-1/2 hours (U.L. testing) and ceiling rated 3-hour (Warnock Hersey testing).

I. Access panels are to be KARP (or acceptable equivalent) Model KRP-150 FR for fire rated applications and Model KDW in non-rated drywall construction and Model DSC-214M for masonry construction.

J. Outside surfaces of access panels are to finish flush with adjacent wall or ceiling surfaces. Panels are to be shop primed and are to be painted by the HVAC Sub-Contractor to match adjacent surfaces, color as directed by the Architect.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor is to furnish equipment, labor, materials, tools, services and facilities necessary for installation of the project, in general, as noted under "Scope" and more fully specified herein. The Contractor is to carefully examine the site, existing conditions, Plans, and
Specifications before submitting their proposal as they will be held responsible for the complete installation in every detail.

B. The Contractor is solely responsible for work, material, and equipment furnished for the contract, including those of his subcontractors, until completion of the project and final acceptance. Damaged work or materials are to be replaced. The Contractor is to provide necessary storage sheds for the protection of the material and equipment for the Contract. Storage sheds are to be located per the approval of the Owner.

C. The Drawings are indicative of the character and scope of the work and are not intended to show each of the details. Before commencing work, the Contractor is to carefully examine all Contract Drawings and Specifications. If any discrepancies occur between the Drawings, or between the Drawings and Specifications, he is to report such discrepancies to the Architect in writing and obtain written instruction as to the manner in which to proceed. No departures from the contract drawings are to be made without prior written approval of the Architect.

D. During the course of construction, conflicts and discrepancies which the Contractor failed to notify the Engineer of are to be interpreted by the Engineer so as to obtain a consistent and workmanlike installation. The Contractor is bound by the Engineer's decision and is to carry out the work at no additional cost to the Owner.

E. Construction is to be executed with the maximum speed consistent with good workmanship.

F. Material and equipment to be furnished under the Contract is to be new and conform to the grade, quality, style, size and standards as specified herein. Equipment is to be the latest standard product as advertised in printed catalogs by reputable manufacturers for the purpose intended and have replacement parts available.

G. Equipment, material or apparatus of any one system is to be the product of one manufacturer, or equivalent products of a number of manufacturers which are suitable for use as indicated in the various systems. Similar equipment, material or apparatus of the same or similar type are to be as manufactured by the same manufacturer.

H. Equipment is to be installed in strict accordance with the manufacturer's instruction for type and capacity of each piece of equipment. The Contractor is to obtain these instructions from the manufacturer and include same with the submission of the equipment. Type, capacity, and application of equipment are to be suitable and capable of satisfactory operation for the purpose intended.

I. The Contractor is to give requisites, notices, obtain and pay for permits, and pay deposits and fees necessary for the installation tests and inspection of work provided under this Specification. These tests are to be conducted as required by the regulations of the Local and/or State authorities.
3.2 PROJECT MANAGEMENT

A. Management of the project is to be provided. It is essential that such management is provided, for without it, poor quality, waste, shortcuts and delays will result. It is important the work of this project be completed during the period specified.

3.3 COORDINATION

A. The Contractor is to cooperate with other contractors and arrange the work to eliminate confliction with the conduit, piping and equipment of other contracts.

B. Although the Drawings are to be indicative of general routings, the actual location of pipes and equipment are to be determined at the site. The Contractor is to confer with the various other contractors on the project as to the locations of different lines of pipes, ducts, and equipment installed under other contracts before erecting any work in order to avoid interference. The Contractor is to insure proper securing and anchoring of work.

C. Changes necessary due to lack of coordination or because of poor workmanship are to be made at no additional cost to the Owner, i.e., should any Contractor proceed with the installation of equipment, pipe, etc., prior to coordinating with the other contractors and that equipment, pipe, etc., prevents proper installation of work of other trades, the offending Contractor is to remove and replace his work at his own cost.

D. Where the Heating Contractor is installing new electrically operated equipment he is to furnish to the Electrical Contractor (or Sub-Contractor) pertinent information regarding electrical requirements of the motor operated and electrical control equipment to be furnished under the contract. Information is to include electrical characteristics, exact rough-in dimensions, information on remote control equipment, special instructions of the manufacturer and wiring diagrams if required.

E. Connections to equipment is to be made in a neat and workmanlike manner, placing the equipment in proper operating condition, with suitable provisions for maintenance or replacement, when available, the equipment manufacturer's recommendations are to be followed in making final decisions.

3.4 RECEIPT OF EQUIPMENT

A. New equipment being used on this project, whether delivered to jobsite or to this Contractor’s place of business, is to be examined (to determine if the equipment was damaged) prior to signature of receipt by the Contractor’s representative. It is the Contractor’s responsibility to file damage claims with the mover (truck, railroad, etc.) at time of receipt of damaged equipment.

3.5 PROTECTION OF EQUIPMENT

A. It is to be the responsibility of the Contractor to protect equipment, piping, insulation, controls and similar items of equipment from dirt, grime, plaster and water during each phase of construction. This protection is to be provided by covering with transparent plastic sheeting, caps or as required to the satisfaction of the Engineer.
3.6 STORAGE OF MATERIAL

A. The Contractor is to erect and maintain proper facilities for protecting materials and equipment furnished under this Contract during each phase of construction until acceptance by the Engineer. Any damaged materials or equipment is to be repaired or replaced by the Contractor at his own expense to the satisfaction of the Engineer and the Owner.

3.7 INTERRUPTION OF EXISTING SERVICES

A. Whenever it becomes necessary to shut down existing services (HVAC, Plumbing, or Electric) in order to make a new connection during the course of the work, the Contractor is to secure the Owner's permission prior to the shutdown and is to arrange the time of such outing to minimize inconvenience to the Owner.

3.8 EXISTING EQUIPMENT BEING REMOVED

A. Where existing equipment is to be removed under this contract, it is to remain the property of the Owner and is to be relocated to an onsite location or hauled away as directed by the Owner. The Contractor is to meet with the Owner as soon as possible after the signing of the Contract to determine what equipment the Owner will retain.

3.9 CUTTING AND PATCHING

A. General:

1. No cutting is to be done which will in any way affect the building structurally.

2. Patching is to match adjacent surfaces, and is to be finished with the same material, paint, etc., as adjacent surfaces.

3. Where ceiling tile or ceiling material must be cut for installation of equipment, piping, etc., the Heating Contractor is responsible for such cutting and patching where required. NOTE: In no case is ceiling tile to be used for support of equipment being installed in ceilings. Install proper supports from building structure above ceilings. Ceiling tile or material must be replaced by the Heating Contractor if it is damaged during this installation.

B. Within the Building:

1. Unless noted otherwise, the HVAC Contractor will be responsible for cutting and patching walls, ceilings and floors as necessary for installation of piping and equipment on this project. The HVAC Contractor is responsible for coordination of placement of piping and equipment so that cutting and patching is minimal.

2. Cutting and patching of the building roof is to be done by the Owners Roofing Contractor who is to be a sub-contractor to the Prime HVAC contractor.

   a. Roof Warranty work is to be performed by...
3.10 ELECTRICAL REQUIREMENTS FOR EQUIPMENT INSTALLATION

A. Unless specified as being furnished by the equipment manufacturer as an accessory with the equipment, the Heating Contractor is to furnish starters and disconnect switches for each electrically operated piece of equipment specified under this Contract. Disconnect switches are to be fused or non-fused as noted on the plans or as required by the National Electric Code. Starters are to be as herein specified.

B. Where disconnect switches and starters are not factory installed, they are to be unit mounted or wall mounted by the Heating Contractor. Locations for disconnect switches and other control devices may not be indicated on the plans. Coordinate locations with the Owner.

C. In any and all cases, it is the responsibility of the HVAC Contractor to coordinate who is providing the required starters or disconnects during bidding and include the cost of such required items in their bid.

D. The Heating Contractor is to wall mount disconnect switches, starters, start-stop switches, etc., in the close vicinity of the equipment being controlled. The Electrical Contractor is to power wire to (and through where required) these devices and is to final connect power wiring to electrically operated equipment being installed by the Heating Contractor. The Heating Contractor is to furnish Shop Drawings of approved electrically operated equipment to the Electrical Contractor for his use. Any changes required to accommodate approved substitute equipment such as larger wire, conduit, breakers, etc., are to be the financial responsibility of the Heating Contractor.

E. DO NOT LOCATE DISCONNECT SWITCHES OVER EQUIPMENT NAME PLATES.

F. Temperature control component such as thermostats, sensors, sensing wells, interlocking relays, and other temperature regulating controls as well as control wiring, incidental power wiring, conduit, etc., as required by this Specification, are to be furnished and installed by the Heating Contractor or his/her ATC Sub-Contractor.

G. Electrical equipment, components and wiring furnished and installed by the Heating Contractor are to conform to the following electrical requirements, codes and regulations:

1. **Underwriter's Labels:** Where applicable, materials and equipment are to bear the label as listed by the National Board of Fire Underwriter's Laboratory.

2. **Regulations:** Electrical installation is to meet the requirements of the National Electrical Code of National Board of Fire Underwriters amended to date. In addition, any State, Municipal or other Authority's laws, regulations or rules applicable to the work are to be followed.

H. Any contactor or starter to which line voltage exceeds 120 volts and which is provided for equipment which will be controlled by automatic temperature control system is to be provided with 120 volt control transformer wired to line side of contactor or starter.
I. Three phase starters may be separate or combination starters/disconnect switches and whether furnished by the equipment manufacturer or by the Contractor, are to have under voltage and phase loss/reversal protection.

J. Any contactor or magnetic starter for equipment, which when energized, is required to energize other equipment, is to be provided with the number of sets of auxiliary contacts required, plus one spare.

K. All wiring is to be AWG copper, Type THW, THHN or THWN and installed in electrical metallic tubing (EMT) except where conduit is run outside the building in which case it is to be installed in rigid galvanized conduit.

L. Each piece of conduit is to be straight, free from blisters and defects, cut square and taper reamed and is to be furnished in 10'-0" lengths with approved couplings and fittings.

M. Short runs of flexible steel conduit is permitted for final connection to motors. Length of flexible conduit is not to exceed 48".

N. Where it is necessary to cross expansion joints in building construction, conduit runs are to be provided with suitable expansion fittings.

O. Each control cabinet, starter pushbutton station, and manual switch controlling equipment furnished under this Contract is to be identified by means of a name tag with the name, function and location of the equipment stated thereon. Name tags are to be made of rigid plastic laminate with engraved letters. Name tags are to be attached with small chrome plated screws.

3.11 SUPPORT FOR DUCTS, PIPES & EQUIPMENT

A. All pipes, ducts, and equipment that are suspended shall be connected directly to the building structure.

B. Pipe and ducts shall not be supported from other pipes, ducts, or equipment. Hanging shall not be permitted from the roof and floor slabs.

C. Hangers from joists shall be attached at the panel points. Pipes and ducts with weights of 50 pound per foot (total for single or multiple runs), routed parallel with bar joists, shall be supported from a minimum of 3 joists at each hanger point (channel members between joists).

D. Where ceiling or wall mounting of equipment is indicated or specified, use suspended platform or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location, unless indicated otherwise on the Drawings. Construct of structural steel members, steel plates, hanger rods, etc., as required or as indicated on the Drawings. Brace and fasten to building structure or to inserts as approved by the Engineer.

E. Equipment suspension assemblies are to be constructed of supporting members of strength to safely withstand stresses to which they may be subjected and to distribute properly the load and impact over building areas. Conform to applicable technical societies standards and to codes and regulations of all agencies having jurisdiction.
F. The Contractor is to submit detailed Drawings for all supports and obtain approval before fabricating or constructing.

G. Hanger rods, angle iron, wall brackets, etc., installed concealed in the building to provide supports for new equipment is to be shop coat primered.

3.12 VIBRATION ISOLATION

A. Isolation mounting shall be provided for all moving equipment where the energy of the vibration is of sufficient magnitude to produce perceptible vibration or structure transmitted noise in occupied areas. Isolation equipment shall be selected, installed and adjusted in accordance with manufacturer's recommendations.

B. All equipment and material shall be installed to operate without objectionable noise or vibration as determined by Architect and Owner. Should such objectionable noise or vibration be produced and transmitted to occupied portions of the building by apparatus, piping or other parts of this work, any necessary changes as approved shall be made by the Contractor.

C. Provide Vibration Isolation kits, and all accessories such as threaded rods or other hangars, for all items as recommended by manufacturer.

3.13 SLEEVES AND PENETRATIONS

A. Contractor shall provide sleeves where pipes pass through walls, partitions, floors, and ceilings.

B. All sleeves shall be properly installed and cemented in place.

C. Holes cut in air barriers (gypsum board, wood sheathing, etc.) for sleeves and penetrations shall not be larger than the diameter of the sleeve or penetration + ½” per side.

D. All penetrations shall be caulked and sealed to prevent air and thermal bypasses.

3.14 PAINTING AND MARKING OF PIPING AND EQUIPMENT

A. Piping, iron work and other equipment installed exposed under this contract throughout the building are to be painted with one (1) coat primer and two (2) coats of the best quality finish paint of colors as selected by the Engineer. Finish coats are to be flat or semi-gloss as directed by the Engineer. Piping covered with white insulation is not to be painted but is to be stenciled.

B. Piping is to be stenciled every 20'-0" and at each change of direction with flow arrows and the Owner's standard legend. Where standard legends have not been developed, commercially available pipe markers as manufactured by Seton (or approved equivalent) will be accepted, or stencil. Stenciling is to match the following legend unless a standard has already been established:

1. Cond Dr. – Condensate Drain Piping

2. HWR – Hot Water Return Piping to Boilers
3. HWS – Hot Water Supply Piping from Boilers

4. Refrig. – A/C Refrigerant Piping

3.15 DIRT, NOISE AND CLEAN-UP

A. The Contractor is to keep the construction area free of rubbish and material during the course of construction insofar as his work is concerned.

B. The exterior and interior premises of the building are to be kept as clean as possible during the entire construction. Weekly clean-up will be mandatory.

C. When, in the opinion of the Engineer, any accumulation of material is obstructing construction progress, the Contractor is to immediately remove such material.

D. Upon completion of the project, the Contractor is to remove rubbish, surplus equipment, etc., and have each area cleaned spotless to a standard as approved by the Engineer.

E. The Contractor is to thoroughly clean equipment, leaving same in first-class working condition, clean permanent filters and install clean, throw-away filters into each piece of equipment.

3.16 RESTORATION AND MAINTENANCE OF SURFACES

A. This Contractor shall replace all surface material and shall restore paving, curbing, sidewalks, gutters, shrubbery, fences, sod and other surfaces distributed during construction to a condition equal to that before work began, furnishing all labor and material required.

B. Restore damaged paved surfaces with new pavement matching that damaged. No permanent paving shall be placed less than 30-days after backfilling, unless approved by the Architect.

C. Replace ceiling tiles damaged during the course of the construction.

D. All material and labor required for repair of defects in trench backfill and paved surfaces shall be supplied by this Contractor for the required Warranty Period.

3.17 OPERATIONS AND MAINTENANCE MANUAL (O&M MANUAL)

A. Operations and Maintenance Manual: The Contractor is to furnish the Owner with three (3) copies of a bound "Operations and Maintenance Manual" containing complete operating instructions, manufacturer's catalog numbers and complete description and parts list of each piece of equipment furnished under the Contract.

1. Include within the O&M Manual a Letter of Certification (copy available upon request) itemizing the equipment, system, instructor and bearing signatures of the employees instructed. The Letter of Certification is to note the number of hours spent in explanation and actual operation of system with maintenance personnel. The letter is to be delivered to the Owner upon completion of the project.
2. The Contractor is to videotape all portions of the training and turn over to the Owner for their future use.

3. Provide a completed start-up checklist report for each piece of equipment listed in the below table. The start-up checklist is to be provided by the manufacturer of the equipment or an approved source (ASHRAE, BCA, etc.). The start-up checklist is to be completed by a technician as described below and who has experience in the start-up of the indicated equipment. The checklist is to be dated and signed by the technician who performed the start-up.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Checklist Provided by</th>
<th>Checklist completed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU</td>
<td>Manufacturer</td>
<td>Factory Certified Rep.</td>
</tr>
<tr>
<td>Pumps</td>
<td>Manufacturer</td>
<td>Factory Certified Tech.</td>
</tr>
<tr>
<td>UVGI</td>
<td>Manufacturer</td>
<td>Factory Certified Tech.</td>
</tr>
<tr>
<td>TAB Report</td>
<td>TAB Sub-Contractor</td>
<td>Tab Sub-Contractor</td>
</tr>
<tr>
<td>ATC</td>
<td>ATC Sub-Contractor</td>
<td>ATC Sub-Contractor</td>
</tr>
</tbody>
</table>

4. For the purposes of the above checklist, the following definitions apply:

a. **Factory Certified Representative**: A start-up technician employed by the manufacturer whose duty is to start-up the equipment and is not responsible for or involved with the installation.

b. **Factory Certified Technician**: A person trained by the manufacturer and having completed specialized training with respect to the equipment but who is employed by a start-up company of the installing Contractor and who may or may not have been involved with the installation. Proof of certification is required.

c. **Contractor**: An employee or a Sub-Contractor of the Contractor who is not required to have specialized factory provided training but who should possess fundamental knowledge of the system being started up and experience requisite of the tasks being performed.

### 3.18 INSPECTIONS

**A.** The following operations are to be performed in preparation for final inspection. This Contractor is to demonstrate to the Owner and the Engineer that all new equipment is operating in compliance with the Drawings and Specifications.

1. **Machinery**: Machinery is to be initially serviced. Machinery is to be test operated and necessary adjustments made to make it perform in compliance with the Drawings and Specifications.
2. **Controls**: All controls will be tested and adjusted by the HVAC Contractor or his/her Automatic Temperature Control Sub-Contractor to achieve the intent of these Specifications. When possible, controls are to be adjusted while the system is operating under full load conditions.

3. **TAB Report**: Testing, Adjusting and Balancing is to be completed and initial forms submitted to the Architect for review prior to final inspection. See Section 23-05-93 – Testing, Adjusting and Balancing.


### 3.19 ADDITIONAL STOCK

A. Contractor is to provide the following additional stock items at the completion of the project.

1. Enough filters for three (3) complete filter changes for each Air Handling Unit

2. A spare change of bulbs for each UVGI system

**END OF SECTION**
HEATING, VENTILATING AND AIR CONDITIONING CONSTRUCTION SPECIFICATION

SECTION 230566 - ULTRAVIOLET IRRADIATION LAMP SYSTEMS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Antimicrobial UV-C lamp systems for duct insertion.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. UV-C: Ultraviolet-C short-wave spectrum.

C. UV-C Lamp System: Unit including UV lamp, power supply, housing, and supports.

D. UVGI: Ultraviolet germicidal irradiation.

1.3 QUALITY ASSURANCE

A. Provide documentation proving compliance with testing requirements of ASHRAE Standard 185.1

B. Provide documentation proving compliance with UL 1995.

C. UVC products shall be from an ISO 9001 manufacturer, or the supplier shall provide proof of 100% inbound and outbound testing of equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Product description with complete technical data, performance data, and product specification sheets.
   2. Maintenance and Operational Manual: Include electrical characteristics; and furnished accessories indicating process operating power, distribution range, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Installation instructions, including factors affecting performance.
   4. Product Data: For lamps, indicating mercury content and lamp life.

B. Product Test Certificates:
   1. Perform factory test on UV lamp, fixture, and system. Submit Product Test Certificates.
   2. Submit report of UV-C effectiveness testing prepared by independent testing organization.

C. Sample Warranty: For manufacturer's warranty.
1.5 DELIVERY, STORAGE AND HANDLING

A. Store UVC fixtures in a clean, dry place and protect from weather and construction traffic. Handle UVC Fixtures carefully to avoid damage to components, enclosures and finish. Leave factory-shipping covers in place until installation is complete. Do not install any damaged components; instead replace them and return damaged components to equipment manufacturer.

B. Comply with manufacturers’ installation instructions regarding wiring and testing and to the drawings and/or specification regarding exact fixture placement for proper energy distribution.

1.6 WARRANTY

A. Manufacturer’s Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. In Unit System
   a. Warranty Period, Housing one year from date of Substantial Completion.
   b. Warranty Period, Lamp 9,000 hours or one year from date of Substantial Completion.
   c. Warranty Period, Ballast 15 year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 ANTIMICROBIAL UV-C LAMP SYSTEMS DUCT INSERTION

A. Manufacturers

1. Ultraviolet Devices ALTRU-V – Basis of Design.
2. American Ultraviolet.
3. Sterilaire.
4. Approved equivalent.

B. Source Limitations: Obtain antimicrobial UV lamp systems from single source from single manufacturer.

C. UVC Fixtures

1. Germicidal UVC Lamps, Housings and mounting structure shall be of the single-ended, bi-axial tube type and be factory assembled and tested. Each UVC fixture shall consist of a lamp, lamp socket, housing, and power supply. The support structure shall consist of a mounting extrusion, mounting brackets and a power supply junction box. It shall be constructed to withstand the
environments of HVAC equipment. Fixtures shall provide for unobstructed (360 degree) UVC irradiance of the air stream.

2. Housing:
   a. Housings shall be constructed of stainless steel in a UL drip-proof design. Housings shall be formed, notched and punched in such a manner so as to incorporate the power source, power cover, lamp sockets and lamp into one integral assembly that maximizes serviceability and precludes lamp pin exposure to the air-stream. Each housing shall be equipped with an internal wire harness sufficient to allow the UVC lamp to be powered by 120VAC electricity. Housing shall include mounting tabs with pre-punched mounting holes to facilitate installation onto a supporting extrusion.

3. Support Structure:
   a. Support Structure shall consist of one or more metal extrusions that shall be mounted via brackets to opposing walls of the plenum or duct. Extrusions shall contain integral wire ways and covers to allow connection of multiple fixtures to a single power supply box.

4. Power Supply:
   a. Power supplies shall be of a high efficiency, high frequency, high Power factor type, 120/230 VAC matched to the lamp and designed to maximize radiance and reliability. They shall have four wire lamp operation rapid start with pre-heat capability. They shall be UL Listed and labeled, and comply with FCC 47, Part 18, non-consumer limits requirements. The ballast shall be protected from failure in the event of end of lamp life lamp failure. The ballast shall be capable of operation indefinitely when powered with no lamp or failed or broken lamp. Each shall be capable of connection to a factory supplied mounting extrusion, equipped with a UL approved and NEC code compliant power connection module.
   b. The power source shall maximize UVC, radiance and reliability and be UL listed for cold and/or moving air streams at temperatures ranging from 55° to 135° F and airflow velocities to 600 fpm.

5. Lamp Sockets:
   a. Sockets shall be constructed of UVC resistant, commercial grade HVAC materials designed for long service. They shall be located out of the air-stream and enclosed in the housing.
   b. The Lamp Socket shall accommodate a single ended four-pin bi-axial 360° radiant lamp.

6. Lamp:
   a. Lamps shall be a high output, 60-watt, T-5 diameter, hot cathode, twin-tube (bi-axial) type.
   b. Lamp tubes shall be constructed of Sodium Barium glass and internally coated, designed to extend lamp life and maintain output. Uncoated quartz lamp tubes shall not be acceptable.
   c. Lamps shall be equipped with a four-pin lamp base that is fully enclosed when inserted into the lamp socket.
   d. The lamp shall produce no less than 80% of its initial UVC output at “end of life.” Lamp life shall be a minimum of 9000 hours of service.
e. Each lamp shall contain no more than 5.0 milligrams of mercury.

f. Lamps shall produce 254nm UV energy at up to 600 fpm air velocity in temperatures from 55° to 135° F without production of ozone.

7. Independent Testing:

a. Housing and Lamp (device), as submitted, is to be independently tested to verify output under the variable operating conditions typically found in HVAC equipment.

8. The UVC system shall be tested to verify performance and conformity to UL/C-UL standards included in UL Category Code ABQK (accessories, Air Duct mounted) Performance:

a. UVC Lamps - Lamps are to be high output, 60 watt, bi-axial design.

1) Lamp performance shall be maintained with no more than a 20% output loss at the end of one year of continuous use.

2) Lamps shall produce 254nm UV light at up to 600fpm air velocity in temperatures from 55° to 135° F.

b. Irradiation - Lamps and Housings are to be installed in sufficient quantity and in such an arrangement so as to provide an equal distribution of UVC energy:

1) When installed, the intensity penetrating the entire moving air stream will be sufficient to disinfect the target micro-organism at a rate of 90% or higher upon the first pass.

2) Third party irradiation, intensity and UV dosage calculations (modeling) shall determine fixture placement, energy distribution and projected disinfection rates as required.

9. Warranty: Housings shall be warranted to be free from defects for a period of one year. Lamps shall be warranted to be free from defects for a period of one year. Lamps shall have a minimum of 80% of new lamp output at the end of 9000 hours.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for UV-C lamp system to verify actual locations of UV lamps and electrical connections before UV-C lamp system installation.

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

3.2 INSTALLATION, GENERAL

A. Install UV-C lamp systems in accordance with manufacturer's installation manual and drawings unless otherwise indicated.

B. Install UV lamps in each UV-C lamp system.
C. Install UV-C lamp systems in locations that are accessible and that will permit servicing and maintenance.

D. Provide sufficient length of wiring loom to facilitate lamp connection to a remotely located power receptacle or power supply housing, such that lamp and loom can be mounted anywhere in the system.

E. Seal ductwork penetrations to maintain integrity of HVAC unit casings.

F. Irradiation: Install quantity of UV-C lamps necessary to provide equal distribution of available UV-C energy. When installed, UV-C energy produced shall be distributed in 360-degree pattern within cavity or plenum space.

G. Intensity, Airborne Pathogen Disinfection Applications: UV-C lamp system modeling shall be included in submittal and must contain necessary calculations to demonstrate 18 – 24 W/sq. ft. of duct surface area to achieve a minimum of 1,000 microwatts/sq. cm equally distributed on the target surface as recommended by ASHRAE.

H. Housing Installation: Power supply housing can be installed inside or outside HVAC units or plenums.

I. UV Lamp Installation: Mount UV lamp to irradiate surfaces, as well as the available line of sight airstream, through proper lamp placement, and incident angle reflection.

J. Safety: Comply with requirements in UL 1995, "Standard of Safety for Heating and Cooling Equipment." Provide mechanical interlock switch on access panels and doors to UV lamp systems, or within view of UV lamp systems, to ensure that UV-C lamp systems will be de-energized when these accesses are opened. Provide warning label per below.

K. Signage: Comply with requirements in UL 1995 "Heating and Cooling Equipment." Mark access panels and doors to UV-C lamp systems with warning signs stating, "WARNING: UV LIGHT SOURCE" and "DISCONNECT POWER BEFORE SERVICING."

3.3 ELECTRIC CONNECTIONS

A. Provide electrical power and service disconnects to hard-wired products requiring electrical connections.

B. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

C. Comply with requirements for service disconnects in Section 262816 "Enclosed Switches and Circuit Breakers."

D. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
3.5 IDENTIFICATION
   A. Identify UV-C lamp systems with equipment labels.

3.6 STARTUP SERVICE
   A. Engage a factory-authorized service representative to perform startup service.

3.7 ADJUSTING
   A. After installation, adjust UV-C lamp systems and supports to maximize exposure to surfaces, before energizing system.

3.8 CLEANING
   A. Wipe lamps clean using manufacturers' recommended cleaning methods and materials.

3.9 DEMONSTRATION & TRAINING
   A. Engage a factory-authorized service representative to train and instruct Owner's maintenance personnel on all aspects of safety, and how to adjust, operate, and maintain UV-C lamp systems.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary to extend the building’s existing Johnson Controls Facility Explorer Building Management System (BMS) to the equipment covered in this project, as shown on the drawings and as described herein. Drawings are diagrammatic only. The BMS work is to be performed by O.Z. Enterprises, LLC based in Pittsburgh, PA.

1.2 SYSTEM DESCRIPTION

A. It is the intent of this project to extend the building’s existing non-proprietary Niagara-based Johnson Controls Facility Explorer DDC system. The Facility Explorer system currently connects to Johnson Controls field equipment controllers (FECs) throughout the building via a Johnson Controls N2 communication trunk. Under the Base Bid, the new Johnson Controls air handling unit ASCs will connect to the Facility Explorer system via the existing N2 communication trunk, but are to be capable of communicating via future BACNET Communications wiring.

B. Should the customer choose to accept the Alternate to add direct digital controls (DDC) to the VAV boxes, which are currently pneumatically controlled, BACnet communication wiring is to be installed throughout the building, connecting all of the VAV FECs and the AHU FECs covered under the Base Bid to the Facility Explorer system. All other equipment in the building currently connected to the Facility Explorer system and unaffected by this project will continue to utilize the N2 communication trunk and must remain integrated into the Facility Explorer 80 (FX80) supervisory controller.

C. At the conclusion of this project, both existing and newly-installed FECs must connect to the existing FX80 supervisory controller currently in the building. This will ensure that all points, alarming, trending and database management can be managed in a single database.

D. All FECs provided by the ATC Contractor shall be fully field programmable by the owner to allow for field customization, both now and in the future, to meet the owner’s exact control strategy requirements and address ongoing changes in those requirements. The customer currently utilizes FECs manufactured by Johnson Controls. In order to maintain consistency across the campus so that parts can be stocked efficiently and the controllers can be programmed using a single programming tool, all FECs shall be products of a single manufacturer, Johnson Controls – No exceptions. The FECs shall also be fully compatible with the FX80 without the need for additional gateways or routers.

E. In addition to other capabilities described hereinafter, the BMS shall include full programmability of all connected nodes (controllers provided by the ATC Contractor) via the web for an authorized user. The BMS shall also include implemented override capability of all controller outputs (for controllers provided by the ATC Contractor) via the web for an authorized user. An authorized user shall also be able to create/edit graphic screens, trends and alarms without the need for any additional hardware and/or software. Coordinate with the
Owner's IT department for Ethernet communication cabling and TCP/IP addresses. Ethernet drops shall be provided by the owner.

F. The entire BMS system in the building shall be fully functional for the start-up, check-out and commissioning processes. In order to achieve that end result, the Controls Contractor shall provide all temporary Ethernet infrastructure necessary for full operation of the BMS network prior to availability of the owner’s Ethernet network. The Controls Contractor shall complete changeover to the owner furnished network and remove any temporary or abandoned infrastructure when the owner’s network is made available for use by the BMS.

G. The BMS shall be designed and installed for use with the enterprise (Owner’s) IT systems. Contractor shall be responsible for coordination with the owner’s IT staff to ensure that the BMS will perform in the owner’s environment without disruption to any of the other activities taking place on that LAN.

H. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

I. The work of the single BMS Sub-Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings, Sequences of Operation and the associated interfacing work as referenced in the related documents.

J. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

K. The Controls Contractor shall have on-site personnel capable of making programming changes and color graphics changes to the BMS throughout the commissioning process.

L. In addition, an authorized user shall also be able to create/edit graphic screens, trends and alarms, upload/download Field Equipment Controllers, Input/Output Modules, Variable Air Volume Box Controller and Networked Thermostat Controller databases, monitor all BACnet Objects including but not limited to Analog and Digital Inputs/Outputs/Values, monitor and override all controller physical input/output points, and edit controller resident time schedules, all without the need for any additional vendor interaction. All hardware and software tools and accessories required to provide the owner with these capabilities shall be furnished as part of this project. NO EXCEPTIONS

M. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

1. Operator information, alarm management and control functions.

2. Enterprise-level information and control access.
3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

4. Diagnostic monitoring and reporting of BMS functions.

5. Offsite monitoring and management access.

6. Energy management

7. Standard applications for terminal HVAC systems.

8. Trending. Trend sample intervals shall be coordinated with the Commissioning Agent.

1.3 SOFTWARE LICENSE AGREEMENT

A. As part of this project the owner and manufacturer agree to extend the current campus licensing agreement to be active to the new components installed herein.

1.4 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.5 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work shall be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.6 QUALITY ASSURANCE

A. The Manufacturer of the BMS digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the FMCS digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

B. The BMS shall be installed complete by competent, trained mechanics directly employed (not subcontractors) by the automatic control system vendor. Control system vendor shall have an established office within a fifty (50) mile radius of the project and that office shall be staffed with installation and service mechanics; factory trained engineers and technicians fully capable of rendering training, instruction, and engineering assistance; as well as providing routine and emergency service on all system components.

C. HVAC Contractors installing their own controls will not be accepted. NO EXCEPTIONS

D. Codes and Approvals:

1. The complete BMS installation shall be in strict accordance to the national and local electrical codes. All devices designed for or used in line voltage applications shall be UL listed. All microprocessor based remote DDC devices shall be listed for both UL916;
Energy Management Systems and UL864, Sub-categories UUKL, UOXX, UDTZ; Fire Signaling and Smoke Control System.

<table>
<thead>
<tr>
<th>Category</th>
<th>UL No.</th>
<th>Title of Standard</th>
</tr>
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<tbody>
<tr>
<td>XARZ</td>
<td>429</td>
<td>Electrically Operated Valves</td>
</tr>
<tr>
<td>XAPX</td>
<td>873</td>
<td>Temperature Indication and Regulating Equipment</td>
</tr>
<tr>
<td>PATZ</td>
<td>916</td>
<td>Energy Management Equipment</td>
</tr>
</tbody>
</table>

2. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

E. All system components shall be fault tolerant.

1. Provide satisfactory operation without damage at 110% and 85% of rated voltage and at +3 hertz variation in line frequency.

2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interface. All bus-connected devices shall be a.c. coupled, or equivalent so that any single device failure shall not disrupt or halt bus communication.

1.7 WORK BY OTHERS

A. The ATC Contractor is responsible to provide control power for his equipment. ATC Contractor shall provide all breakers, transformers, etc., as required to provide power to the ATC components, control panels, etc.

1.8 SUBMITTALS

A. Before beginning any work of installation, the manufacturer of the automatic control system shall submit for review of the Owner detailed schematic drawings of completely integrated drawings showing both new and existing control equipment, scaled drawings of all control cabinets and panels, descriptions of operation, and descriptive literature of all equipment to be furnished. This submission shall include complete control wiring diagrams covering all interlock and safety wiring.

B. The ATC Contractor shall submit prior to installation six (6) sets of installation drawings and control strategies for review by the Owner. These drawings shall include the physical location of the building control system equipment and system architecture. The complete sequence of operation of the control system shall be provided.

C. The review of the shop drawings and the use of the review stamp shall be only for conformance with the design concept. The stamp does not indicate acceptance of every detail of the drawings, quantities, nor of the work methods indicated thereon. The review stamp does not relieve the ATC Contractor of his responsibility to comply with all requirements of this specification.

D. Shop Drawings:

1. List of connected data points, including point type, object name, expanded ID, address, connected control unit and input device.
2. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

3. System configuration with peripheral devices, batteries, power supplies, diagrams, modems and interconnections.

4. Descriptive data and sequence of operation of operating, user and application software.

5. List of alarms set up at system start up.

6. List of trends set up at system start up.

7. Shop drawings are to be prepared by the ATC contractor.

E. Product Data: Catalog sheets, specifications, control/wiring, schematic drawings and installation instructions for each item specified. Include the valve and damper schedules and flow diagram system.

1.9 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner’s Representative upon completion of the project and include the following:

   a. Table of Contents

   b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

   c. Manufacturers product data sheets or catalog pages for all products including software.

2. The Controls Contractor shall provide O & M Manuals that are organized in a logical, concise easy to use format. In addition, the BMS overview drawings shall accurately reflect "as-built” conditions. To the extent that the original submittal package must be totally redone in order to satisfy these requirements, the Controls Contractor shall make the necessary changes at no additional cost to the owner.

1.10 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

   ASC Application Special Controllers
   FEC Field Equipment Controllers
   FMCS Facility Management and Control System
   NAC Network Area Controller
   IDC Interoperable Digital Controller
   IBC Interoperable BACnet Controller
2.1 DIRECT DIGITAL CONTROLS

A. The Johnson Controls Facility Explorer BMS system is to be provided by O.Z. Enterprises, LLC based in Pittsburgh, PA. Please contact Ryan Birtwell at 412-283-4649 or rbirtwell@ozenter.com.

2.2 GENERAL

A. The BMS shall be comprised of a network of interoperable, stand-alone FECs, an FX80 supervisory controller, graphical user interface software, portable operator terminals, printers, network devices and other devices as specified herein.

B. Any bidder will be required to map and seamlessly integrate all connected points into the existing Facility Explorer BMS to form a single expanded database.

C. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet and LonWorks technology communication protocols in one open, interoperable system.

B. All components and controllers supplied under this contract shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.

C. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 10 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

A. The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local host computer system.

B. Local area network minimum physical and media access requirements:
   1. Ethernet; IEEE standard 802.3
   2. Cable; 100 Base-T, UTP-8 wire, category 6
   3. Minimum throughput; 100 Mbps, with ability to increase to 1000 Mbps

2.5 NETWORK ACCESS

A. Remote Access.
   1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via the customer’s Intranet to a corporate server providing access to an Internet Service Provider (ISP). Owner agrees to pay monthly access charges for connection and ISP.

2.6 NETWORK AREA CONTROLLER (FX80)

A. The ATC contractor shall utilize the school’s existing FX80 Network Area Controller (NAC). The FX80 shall monitor the network of distributed field equipment controllers (FECs), provide global strategy and direction, and communicate on a peer-to-peer basis with other FX80 controllers.

B. The ATC subcontractor is responsible for update the graphics on the FX80 for the equipment impacted by this project.

C. The FX80 shall support up a minimum of ten (10) concurrent users.

D. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one FX80.

E. Diagnostics – The FX80 shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The FX80 shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

F. Power Failure – In the event of the loss of normal power, the FX80 shall continue to operate for a period of up to 5 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
2.7 DDC System Controllers

A. Field Equipment Controllers

1. The FECs shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

2. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

3. The FEsC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

4. The FECs shall include a removable base to allow pre-wiring without the controller.

5. The FECs shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Field Controller Bus - Normal Data Transmission
   g. Field Controller Bus - No Data Transmission
   h. Field Controller Bus - No Communication
   i. Sensor-Actuator Bus - Normal Data Transmission
   j. Sensor-Actuator Bus - No Data Transmission
   k. Sensor-Actuator Bus - No Communication

6. The FECs shall accommodate the direct wiring of analog and binary I/O field points.

7. The FEsC shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      Analog Input, Voltage Mode, 0 - 10 VDC
      Analog Input, Current Mode, 4 – 20 mA
      Analog Input, Resistive Mode
Binary Input, Dry Contact Maintained Mode
Binary Input, Pulse Counter Mode

b. Binary Inputs - shall be configured to monitor either of the following:
   Dry Contact Maintained Mode
   Pulse Counter Mode

c. Analog Outputs - shall be configured to output either of the following:
   Analog Output, Voltage Mode, 0 – 10 VDC
   Analog Output, Current Mode, 4 – 20 mA

d. Binary Outputs - shall output the following:
   24 VAC Triac

e. Configurable Outputs - shall be capable of the following:
   Analog Output, Voltage Mode, 0 – 10 VDC
   Binary Output Mode, 24 VAC Trial

8. The FECs shall have the ability to reside on a Field Controller Bus (FC Bus).
   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet
   b. The FC Bus shall support communications between the FECs and the NAC.
   c. The FC Bus shall also support Input/Output Module (IOM) communications with the
      FEC and with the NAC.
   d. The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
   e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and
      the furthest connected device.

9. FECs shall be available in a 10 point version (2 UI, 1 BI, 3 BO, 4 CO) and a 17 point
    version (6 UI, 2 BI, 3 BO, 2 AO, 4 CO). FEC shall be able to expand I/O point capacity
    via the addition of Input/Output Modules and Network Sensors.

10. The FECs shall have the ability to monitor and control a network of sensors and actuators
    over a Sensor-Actuator Bus (SA Bus).
    a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting
    b. The SA Bus shall support a minimum of 10 devices per trunk.
    c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and
       the furthest connected device.
11. The FECs shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

12. The ATC Contractor shall provide FECs with unused Input/Output Module (IOM) capacity such that IOMs can be added to any existing FEC to achieve additional point capacity of 15% for each type of point (AI, BI, AO, BO, PI) currently part of the FEC input/output configuration. NO EXCEPTIONS. Additional IOM capacity shall be detailed for each FEC as part of the submittals:

B. Input/Output Module

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the associated FEC.

2. The IOM shall communicate with the FEC over the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

3. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

4. The IOM shall be available in 4 point (4 BI), 6 point (2 UI, 2 UO, 2 RO), 12 point (4 UI, 4 UO, 4 RO) and 17 point (6 UI, 2 BI, 2 AO, 3 BO, 4 CO) versions.

5. The IOM shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      Analog Input, Voltage Mode, 0-10 VDC
      Analog Input, Current Mode, 4-20 mA
      Analog Input, Resistive Mode
      Binary Input, Dry Contact Maintained Mode
   b. Binary Inputs - shall be configured to monitor either of the following:
      Dry Contact Maintained Mode
      Pulse Counter Mode
   c. Analog Outputs - shall be configured to output either of the following:
      Analog Output, Voltage Mode, 0-10 VDC
      Analog Output, Current Mode, 4-20 mA
   d. Binary Outputs - shall output the following:
      24 VAC Triac
   e. Universal Output - shall be configured to output any of the following:
      Analog Output, Voltage Mode, 0-10 VDC
Analog Output, current Mode, 4-20 mA
Binary Output Mode, 24 V AC/DC FET
f. Relay Output – 120/240 VAC
g. Configurable Outputs - shall be capable of the following:
   Analog Output, Voltage Mode, 0-10 VDC
   Binary Output Mode, 24 VAC Triac

6. The IOM shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Normal Data Transmission
   g. No Data Transmission
   h. No Communication

C. Variable Air Volume Controller

1. The Variable Air Volume Modular Assembly (VMA) controller shall be a programmable, digital controller that communicates via BACnet MS/TP protocol.

2. VMA shall include an integrated pressure sensor (0 to 1.5 in WC) and actuator (35 lb-in) in a pre-wired unit.

3. VMA shall connect to Network Sensors for zone and discharge air temperature sensing.

4. Actuator shall have 60 second drive time from full open to full closed position.

5. VMA point capacity shall be capable of being expanded by adding IOMs to the Sensor Actuator bus.

6. VMA shall support up to 4 zone temperature sensors and 5 discharge air temperature sensors.(on the SA bus)

7. VMA shall be available in two versions:
   a. Cooling only version
   b. Cooling with reheat version (3 BO and 2 CO added)

D. Networked Thermostat Controller
1. Networked Thermostat Controller shall be a networked device that communicates via BACnet MS/TP protocol.

2. Networked Thermostat Controller shall be available with occupancy sensing capability built into the device.

3. Networked Thermostat Controller BACnet MS/TP communication capability shall enable remote monitoring and programming from the operator workstation.

4. Networked Thermostat Controller shall employ a unique, Proportional-Integral (PI) time-proportioning algorithm that virtually eliminates temperature offset associated with traditional, differential-based thermostats...

5. Networked Thermostat Controller shall be available in multiple versions to better match application requirements. Additional features include, but are not limited to, the following:
   a. Occupancy override
   b. Fan on/off and speed control
   c. Discharge air sensor
   d. Configurable binary inputs

2.8 DATABASE BACKUP AND STORAGE

A. The FX80 shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the FX80. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The FX80 database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.9 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Microsoft Edge, Mozilla Firefox, or Google Chrome. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:
1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the FX80 or in the existing PBOE web supervisor server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
   a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
   b. Schedule times shall be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
   c. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
   d. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
   e. View logs and charts
   f. View and acknowledge alarms

7. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.10 SERVER FUNCTIONS AND HARDWARE

A. The BMS Contractor shall expand the customer’s existing Niagara Framework Web Supervisor DDC system currently used for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS FX80 Controllers to
facilitate greater fault tolerance and reliability. The existing Niagara Framework Web Supervisor DDC system shall be upgraded to the latest release by the BMS Contractor.

B. Provide and maintain an Audit Log that tracks all activities performed on each FX80 and the Web supervisor databases. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the web Supervisor), to another FX80 on the network, or to another server. For each log entry, provide the following data:

1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

C. Alarms

1. Alarms shall be routed directly from the FX80 Controllers to the existing PBOE Niagara Framework web supervisor server. It shall be possible for specific alarms from specific points to be routed to specific end devices (phones, emails) and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

   a. Log date and time of alarm occurrence.
   b. Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
   c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
   d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
   e. Provide the ability to direct alarms to an e-mail address or cell phones. This must be provided in addition to the pop up window described above. Systems that use e-mail and cell phones as the exclusive means of annunciating alarms are not acceptable. BMS Contractor shall coordinate implementation of this feature with the owner as part of the work of this project.
   f. Any attribute of any object in the system may be designated to report an alarm.

2. The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions

3. The BMS shall annunciate application alarms at minimum, as required by the Contract Documents.

D. Reports and Summaries

1. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall be capable of providing the following reports:
All points in the BMS
All points in each BMS application
All points in a specific controller
All points in a user-defined group of points
All points currently in alarm
All points locked out
All BMS schedules
All user defined and adjustable variables, schedules, interlocks and the like.

E. Schedules

1. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

   a. Weekly schedules
   b. Exception Schedules
   c. Monthly calendars.

2. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

3. It shall be possible to define one or more exception schedules for each schedule including references to calendars

4. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

5. Changes to schedules made from the User Interface shall directly modify the Network Area Controllers schedule database.


F. Password

1. Multiple-level password access protection shall be provided to allow the user/manager to manage interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

2. Each user shall have the following: a user name, a password, and access levels.

3. The system shall allow each user to change his or her password at will.

4. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
5. A minimum of five levels of access shall be supported individually or in any combination as follows:

   Level 1 = View Data
   Level 2 = Command
   Level 3 = Operator Overrides
   Level 4 = Database Modification
   Level 5 = Database Configuration
   Level 6 = All privileges, including Password Add/Modify

6. A minimum of 100 unique passwords shall be supported.

7. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

G. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

H. Dynamic Color Graphics

1. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

2. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

3. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
   a. All graphics shall be fully scalable
   b. The graphics shall support a maintained aspect ratio.
   c. Multiple fonts shall be supported.
   d. Unique background shall be assignable on a per graphic basis.
   e. The color of all animations and values on displays shall indicate if the status of the object attribute.

4. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device.
5. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
   a. The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
   b. In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

6. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

I. Historical trending and data collection
   1. Each FX80 shall store trend and point history data for all analog and digital inputs and outputs, as follows:
      a. Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:
         b. Defined time interval
         c. Upon a change of value
         d. Each NAC shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
   2. Trend and change of value data shall be stored within the FX80 and automatically uploaded to the existing PBOE web supervisor dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
   3. The system shall provide a configurable data storage subsystem for the collection of historical data.

J. Trend data viewing and analysis
   1. Provide a trend viewing utility that shall have access to all database points.
   2. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
   3. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
   4. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
5. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

6. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

7. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.11 SENSING DEVICES

A. General:

1. Input/output sensors and devices shall be closely matched to the requirements of the DDC panel for accurate, responsive, noise free signal input/output.

2. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.

3. In no case shall computer inputs be derived from pneumatic sensors.

B. Temperature Sensors:

1. Resistance temperature detector (RTD) type of 1000 ohm balco, 1000 ohm platinum.

2. RTD’s shall have zero and space adjustments to allow calibration to a common standard.

3. Thermistor type temperature sensor 10k ohm with 11k shunt.

C. Relative Humidity Sensors:

1. Capacitance type with 5% to 95% range.

2. Duct mounted humidity sensors shall be provided with a sampling chamber and be located as recommended by the humidifier manufacturer.

3. Wall mounted sensors shall be provided with covers identical to temperature sensors.

4. Relative room humidity sensors shall be accurate to + 2%.

5. Have adjustments to allow calibration to a common standard.

D. Carbon Dioxide (CO2) Space Sensors

1. Sensor shall be wall mounted type

2. Sensor to be used for sensing carbon dioxide (CO2) in accordance with single-beam, dual wave-length method

3. No maintenance or recalibration required

4. CO2 measuring range: 0-2000 ppm; accuracy: +/- 2% or reading

5. Selectable output of: 0-20mA; 4-20mA; 0-10VDC

6. 24VAC Power
E. Differential and Pressure Sensors and Flow Switches:
   1. Static Pressure Analog Sensors
   2. Shall be high accuracy suitable for the low velocity pressures to be encountered.
   3. Selected for approximately 50% over range
   4. Have a 4 to 20 ma output.
   5. Connect to the airflow measuring station with valved lines for testing and calibration.
   6. Where applicable, shall have adjustments for zero and span.

F. Outputs:
   1. Control relays and analog output shall be compatible with the DCP output signals.
   2. Relays shall be suitable for the loads encountered
   3. Analog outputs shall be designed for precision closed-loop control with repeatability error no greater than 1-1/2 %.

G. Equipment Operation Sensor/Relays:
   1. Start/Stop/Status Inputs for Fans and Pumps: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current. Current-sensing relays shall be similar to RIBX series.

2.12 THERMOSTATS OR ROOM TEMPERATURE SENSORS
   A. New room thermostats shall be installed as a direct replacement to the existing room thermostat in the same location. Any relocation of room thermostats, at the control manufacturer's recommendation to improve performance, shall be reviewed by the Owner.

2.13 PROGRAMMING
   A. Provide all application programming as required to demonstrate conformance with the sequence of operation.
   B. Provide all programming at the remote site operator workstations as required to view, override, receive alarms and monitor from those locations.
   C. Fine tune control loops in the field.

PART 3 EXECUTION

3.1 INSTALLATION/COORDINATION
   A. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
   B. Ensure system is completed and commissioned.
3.2 RECORD DRAWINGS AND FINAL ADJUSTMENT  
A. At completion of the job, the controls contractor shall furnish six (6) copies of corrected wiring diagrams to the owner for review.

3.3 TRAINING  
A. The control manufacturer shall also provide instructions to familiarize the owner’s personnel with the system operation.

B. Provide 8 hours of Owner Training.

3.4 USER PROGRAMMABILITY  
A. It shall be possible for the operator to modify system functions independently after receiving the training from the ATC contractor as hereinbefore specified.

3.5 MAINTENANCE  
A. Include under this contract two (2) complete on site inspections, one in heating season and one in cooling season. Inspections are to be coordinated with the owner and supervised by an owner representative. Inspect, calibrate and adjust controls as required and directed.

B. Include under this contract one (1) full year system warranty against defects in equipment and workmanship. Provide remote monitoring for troubleshooting, company replacement and system adjustment as part of this warranty.

C. The above required inspection and contractors’ warranties are to be provided in addition to the contractors ongoing maintenance agreement with the owner/campus. At the conclusion of the contractor warranty the owner will amend their maintenance agreement to include the components installed under this project.

3.6 ELECTRIC WIRING  
A. Electrical wiring products shall meet or exceed those specified in applicable portion of Division 26 ELECTRICAL.

B. Except for motor feeders and for wiring between motors, motor controllers, feeder panels, fuses, circuits breakers and buss bars all of the electrical work required for the automatic temperature control system including but not limited to power to ATC panels, breakers in electrical panels for power to ATC control panels, time switches, damper motors, damper switches, electric thermostats, electric relays, interlocking wiring, wire, conduit, transformers, etc. shall be provided and installed by the control contractor. All work shall be in accordance with all applicable state and local codes. Temperature control contractor shall include wiring diagrams in his shop drawing submittals and shall carefully examine the electrical drawings prior to same. It shall be the automatic temperature control contractor’s responsibility to provide all wiring required to achieve the functions called for in these specifications.

C. Any power requirements of damper motors, control equipment, etc., including 120 VAC power to the temperature control panels is to be completed by the ATC.

D. All electric wiring incidental to all control and safety devices covered under this section of the specifications shall be direct responsibility of the manufacturer of the automatic control equipment. All wiring shall be done in strict accordance with applicable state and local codes.
E. Control wiring in plenums shall be furnished and installed in EMT or conduit or an approved shielded cable for plenum use.

F. The control manufacturer shall furnish and install all required interlock wiring unless otherwise specified. The control manufacturer shall carefully coordinate his work with equipment manufacturers.

3.7 TRANSFORMERS AND TRANSFORMER WIRING

A. Transformers shall be provided for electric or electronic controls. For temperature control system, each transformer shall be connected to an electric circuit, which serves no other equipment. Spare circuits in electric panels may be used for controls. Control wiring shall not be connected to lighting circuits. When controls serve an individual air-handling units, transformers may be connected to fan-motor leads of the unit controlled.

3.8 CONTROL PANELS – ALL TYPES

A. Furnish and install local control cabinets where specified or where recommended by the control manufacturer and accepted by the Professional.

B. All control cabinets shall, wherever possible, be mounted with the centerline of the control cabinet five feet above finished floor.

3.9 WARRANTY

A. Manufacturer's standard warranty, one-year parts and labor, from date of final acceptance, minimum four callbacks.

END OF SECTION
HEATING, VENTILATING AND AIR CONDITIONING CONSTRUCTION SPECIFICATION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-duct terminal units.
   1. Constant-volume units.
   2. Variable-volume units.

1.2 RELATED REQUIREMENTS

A. Division 23

1.3 REFERENCE STANDARDS

B. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017.

1.4 SUBMITTALS

A. See Section 230500 for submittal procedures.
B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc (250 to 1000 Pa).
D. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
E. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
F. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. Manufacturers:

1. Johnson Controls, Inc

2. Metalaire, a brand of Metal Industries Inc

3. Price Industries, Inc

B. General:

1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.

2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

C. Unit Casing:

1. Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel with G90 zinc coating.

2. ASTM B-177 compliant for withstanding 125 jour salt spray.

3. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
4. Unit Discharge: Rectangular, with slip-and-drive connections.

5. Acceptable Liners:
   a. 1/2 inch (13 mm) thick, coated, fibrous-glass complying with ASTM C1071, C1136 and C665.
      1) Secure with adhesive and mechanical fasteners.
      2) Cover edges exposed to airstream with metal nosing.
      3) Cover liner with non-porous foil.
      4) Maximum thermal conductivity of 0.24.
   b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.
   c. Liner to comply with ASTM G21 (resistance to mold, fungus, mildew growth).

D. Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating on nylon bearings.
   2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak damper blades for tight airflow shutoff.
   4. Provide internal stops for both full open and closed positions.

E. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel with G90 zinc coating, factory-installed on terminal discharge with rectangular outlet, duct connection type.
      a. Access Door: Gasketed and insulated located on bottom, on top, and downstream of coils.
   2. Coil Fins: Aluminum or aluminum plated fins spaced minimum 10 fins per inch, mechanically-bonded to seamless copper tubes.
   3. Coil leak tested to minimum 450 psig (2413 kPa).
   4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.
F. Controls:
   1. Terminal Unit Controls:
      a. Provide field installed controls, refer to Section 230914.
      b. Sequence of Operation: Zone temperature control with airflow and coil discharge monitoring.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 230548.

E. Do not support from ductwork.

F. Primary Airflow Sensor
   1. For >6” Ø utilize single axis differential pressure airflow sensor.
   2. For ≤ 6” Ø utilize at least two (2) perpendicular traverse sensors.
   3. Equal cross-sectional area or log-linear traverse airflow sensors.
   4. Provide output utilizing average of the pressure sensor readings.

G. Connect to ductwork per the details on the drawings.

H. Provide flex duct and flex connection to reduce vibration transmission.

3.2 FIELD QUALITY CONTROL

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

3.3 CLEANING

A. Vacuum clean coils and inside of units.

END OF SECTION
HEATING, VENTILATING AND AIR CONDITIONING CONSTRUCTION SPECIFICATION

SECTION 237413 – PACKAGED OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 GENERAL

2.1 SECTION INCLUDES

A. Indoor and outdoor air handling units and components as scheduled and shown on drawings.
B. Motor disconnects, motor starters, and variable frequency drives.

2.2 RELATED SECTIONS

A. The requirements of the General Conditions, Supplementary Conditions, Division 1, equipment schedules, and drawings apply.

2.3 REFERENCES

A. AMCA 99 – Standard Handbook
B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes
C. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters
D. AMCA 611-95 – Methods of Testing Airflow Measurement Stations for Rating
E. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
F. ANSI/UL 900 – Test Performance of Air Filter Units
G. AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment
H. AHRI 410 – Forced-Circulation Air Cooling and Air Heating Coils
I. ANSI/AHRI 430 – Performance Rating of Central-Station Air Handling Units
J. ASHRAE 52.1/52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
K. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality
L. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
N. NFPA 70 – National Electric Code (conductors, equipment and raceways)
O. NFPA 90A – Installation of Air Conditioning and Ventilation Systems
P. SMACNA – HVAC Duct Construction Standards
Q. UL-181 – Mold Growth and Humidity Test
2.4 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.

B. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer. Alternate equipment manufacturers are acceptable if equipment meets scheduled performance requirements and dimensional requirements.

2.5 COORDINATION

A. If equipment is supplied by a manufacturer other than the one named, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. This coordination shall include (but is not limited to) the following:

1. Structural supports for units.
2. Size and location of concrete bases/housekeeping pads
3. Location of roof curbs, unit supports and roof penetrations
4. Ductwork sizes and connection locations
5. Piping size and connection/header locations
6. Interference with existing or planned ductwork, piping and wiring
7. Electrical power requirements and wire/conduit and over current protection sizes.
8. Trap height requirements

B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer other than manufacturer named as basis of design.

2.6 RATINGS AND CERTIFICATIONS

A. Unit shall conform to AMCA 210 for fan performance ratings.

B. Unit shall conform to E.T.L. standards. Unit shall be ETL listed.

C. Unit sound ratings shall be reported in accordance with AHRI 260 for inlet and discharge sound power levels.

D. Unit casing radiated sound ratings shall be reported in accordance with ISO 9614 parts 1&2 and ANSI S12.12.

E. Unit shall conform to AHRI 410 for capacities, pressure drops, and selection procedures of air coils.

F. Unit shall conform to ANSI/AHRI 430 for all fabrication procedures of air handling units.

G. Motors covered by the Federal Energy Policy Act (EPACT) shall meet EPACT requirements.

H. Damper performance shall comply with AMCA 500.
I. Airflow Monitoring Stations shall be rated in accordance with AMCA 611-95 and bear a Certified Ratings Seal for Airflow Measurement Performance.

J. Units shall be ISO 9001 certified.

K. Units shall be manufactured in an ISO 9002 certified facility.

L. Filter media to comply with ANSI/UL 900 listed Class I or Class II.

M. Control Wiring comply with NEC codes & ETL requirements.

N. Units shall comply with energy use AHSRAE 90.1.

2.7 SUBMITTAL DOCUMENTATION REQUIRED

A. Furnish fan performance ratings and fan curves with specified operating point clearly plotted.

B. Furnish drawings indicating unit dimensions, required clearances, field connection locations, wiring diagrams, shipping drawings, and curb drawings.

C. Furnish performance report showing unit level performance data including: fan(s), motor(s), coil(s) and other functional components. Performance report shall also include unit casing performance.

D. Furnish operation and maintenance data, including instructions for lubrication, filter replacement, motor and drive replacement, and condensate pan cleaning; spare parts lists, and wiring diagrams.

E. Adjust and report performance ratings for the proper altitude of operation.

F. Report air-handling unit performance ratings in accordance with ANSI/AHRI-430 (static pressure, airflow, fan speed, and fan brake horsepower).

G. Report static pressure profiles by component section.

H. Report coil ratings in accordance with AHRI-410 (capacities and pressure drops).

I. Report unweighted octave band AHU sound power for inlets and outlets rated in accordance with AHRI Standard 260. Provide eight data points, the first for the octave centered at 63 Hz, and the eighth centered at 8,000 Hz. Manufacturer shall not use sound estimates based on bare fan data (AMCA ratings), nor use calculations like the substitution method based on AHRI 260 tests of other AHU products. Provide data for inlets and outlets as scheduled. Report unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.

J. Airflow measuring device performance shall be certified and rated in accordance with AMCA-611. Report data in accordance with AMCA-611. Provide AMCA Certified Rating Seal for Airflow Measurement Performance.

K. Report panel deflection at +/-8” w.g., stated in terms of ‘L/X’ where ‘L’ is the casing panel length and ‘X’ is a constant provided by the AHU manufacturer.

L. Report casing leakage rate at +/-8” w.g., specified in terms of percentage of design airflow.

M. Report weight loads and distributions by component section.
N. Report product data for filter media, filter performance data, filter assembly, and filter frames.

O. Report electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

P. Report motor electrical characteristics.

2.8 DELIVERY, STORAGE AND HANDLING

A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).

B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.

C. Follow manufacturer’s recommendations for handling, unloading and storage.

D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.

E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.

F. Enclose and protect control panels, electronic or pneumatic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.

G. Seal openings to protect against damage during shipping, handling and storage.

H. Wrap indoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively AHU must be tarped for shipment and storage.

I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.

J. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

2.9 WARRANTY

A. Provide warranty for 18 months from date of shipment. Warranty shall cover manufacturer defects. Warranty work shall be performed by manufacturer’s factory-trained and factory-employed technician.

B. Include factory-provided controls in the parts warranties.

C. Parts associated with routine maintenance, such as belts and air filters shall be excluded.

2.10 SYSTEM STARTUP

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Comply with manufacturer’s start-up requirements to ensure safe and correct operation and integrity of warranty.
PART 2 PRODUCTS

2.11 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design Product: provide product indicated on schedule as YORK® Solution™ Outdoor by Johnson Controls Inc.

B. Alternately, provide product, subject to compliance with requirements, by one of the following:
   1. Trane Performance Climate Changer, Model CSAA
   2. Daikin Applied Custom
   3. Approved Equal (Prior Written Approval by Engineer of Record is Required)

2.12 GENERAL DESCRIPTION

A. Air Handling Unit(s) (AHU) shall consists of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, controls, components, and accessories; as shown on drawings, schedules, and specifications.

B. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, electrical characteristics, sound, casing leakage, panel deflection and casing thermal performance.

C. AHU shall maintain structural integrity when wall panels are removed.

D. Provide internal components and accessories as specified and scheduled. Components and accessories shall be installed by the AHU manufacturer in an ISO-9002 certified facility.

E. Unit[s] shall be ship in one piece. Split unit(s) only where necessary for shipping and installation.

F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.

G. For AHU segments that must be broken down for rigging and installation: segment shall be disassembled and reassembled by manufacturer’s factory-trained service personnel.

H. Manufacturer shall perform a field leakage test to confirm 1% maximum leakage per Section 2.27. Manufacturer shall provide a written statement confirming that the unit is built to the manufacturer’s factory standards and that the unit will carry the full warranty.

2.13 STANDARDS COMPLIANCE

A. Manufacturer shall comply with ratings and certifications referenced in this specification.

B. Manufacturers who do not comply with ANSI/AHRI-430 shall factory test EACH unit to verify brake horsepower rating, airflow performance and total static pressure performance. See Section 2.27 (VERIFICATION OF PERFORMANCE) for testing requirements.

C. Manufacturers who do not conform to requirements of AHRI 260 for ducted discharge and return air sound shall submit EACH unit to an independent sound test laboratory for AHRI 260 testing. The test laboratory shall conform to AHRI 260, Section 4.4, Test Equipment and Facilities.
2.14 BASE RAIL

A. Unit(s) shall be provided with structural base rail under the full perimeter of the unit, formed from mill galvanized steel.

B. Structural steel shall be installed providing clearance for proper external trapping of drain pans.

C. Unit(s) shall be provided with base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

2.15 CASING

A. Casing construction shall not rely on the casing panels for structural integrity.

B. Casing panels shall be 2” double-wall construction with thermal break. Thermal break shall be between interior and exterior liner of the panel assembly, and between the panel and casing framework.

C. Provide casing with minimum thermal resistance (R-value) of 13 hr-ft2-°F/BTU. Exposed insulation is not acceptable.

D. Casing panel insulation shall be injected polyurethane foam. Foam insulation shall be manufactured by EcoMate®. Rigid foam board panels shall not be used.

E. Casing framework downstream of cooling coil shall be filled with injected polyurethane foam insulation. Foam insulation shall be manufactured by EcoMate®.

F. All exterior and interior casing panels (roof, wall, floor, access door) shall be made of galvanized steel.

G. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

H. Insulation system provided shall be resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

I. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined double-walled panels insulated with injected foam shall be hermetically sealed at each corner and around their entire perimeter to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall.

J. Unit shall conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections down to a minimum of 50 CFM measurable leakage or 5,000 design CFM.

K. Provide wall panels and access doors that deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. ‘L’ is the panel-span length and ‘L/240’ is the deflection at panel midpoint.

L. Provide floors and roofs that deflect no more than L/240 when subjected to a 300 lb static load at mid-span. ‘L’ is the panel-span length and ‘L/240’ is the deflection at panel midpoint.
M. Provide outdoor AHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb./ft². ‘L’ is defined as the panel-span length and ‘L/240’ is the deflection at the panel midpoint.

N. Condensation shall not form anywhere on unit exterior at 53 deg F supply air and 81 deg F DB / 73 deg F WB exterior ambient. Manufacturer shall supply an external condensation performance line, plotted on the psychrometric chart, based on actual test data. Plot will show the exterior conditions at which unit will sweat given the design supply air temperature. Manufacturer shall clearly indicate whether the design conditions will or will not result in external condensation forming anywhere on the unit exterior. If the unit will sweat, indicate where sweating will occur. Unit exterior includes the base, base rail, roof, corners, doors, door frames, and under the cooling coil drain pan.”

2.16 ROOF SYSTEM

A. Roof system outer layer
   1. Shall have no points of penetration.
   2. Shall use no fasteners.
   3. Shall have no metal-to-metal seams joints.
   4. Shall not use or require caulking.

B. Roof system shall be warranted by manufacturer against water penetration for a period of 10 years.

C. Roof system shall be sloped with a minimum pitch of 1/8” per foot.

D. Roof system shall overhang side and end panels by a minimum of 2.”

E. Doors shall have drip edge guard above door frame. Drip edge guard shall extend 2” beyond door surface.

F. Field connection at roof of section splits shall not require use of fasteners, sealants or metal seam caps.

2.17 ACCESS DOORS

A. Provide double wall access door(s) that meet requirements for the AHU casing.

B. Thermal break door(s) shall incorporate a thermal break in both the door frame and the door panel.

C. Provide industrial-style stainless steel hinges that permit 180 degrees of door swing.

D. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or “paw” latches are not acceptable.

E. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.

F. Provide access doors with a locking hasp to accommodate a lockout device.
G. Provide double-pane viewing windows. Windows shall be a non-condensing type consisting of a desiccant dehumidification layer. Minimum dimension shall be 3” x 8”.

2.18 COILS: HEATING AND COOLING

A. ACCEPTABLE MANUFACTURER
   1. AHU manufacturer, except where noted in contract documents.

B. GENERAL DESCRIPTION
   1. Coils shall meet or exceed performance scheduled on drawings.
   2. Coils shall be provided with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop, wherever applicable. Coils circuits shall be designed such that the fluid velocity is within the range of certified rating conditions at design flow.
   3. Cooling coils shall be provided with a maximum face velocity as scheduled. Face velocity calculations shall be based on the finned area of the coil.
   4. Cooling coil shall be provided with drain pan that is sufficient to contain coil condensate. Drain pan shall extend a minimum of 6” downstream of the face of the coil.
   5. Coil segment casing shall accommodate full-face or reduced-face coils as scheduled.
   6. Access shall be provided of at least 6” between coils. Access panel or door shall be easily operable and are easily removable with no special tools, as shown on drawings.
   7. Access doors shall be located to provide clearance for pipe insulation, connectors, and accessories. Space shall allow a minimum of 90 degrees of door swing.
   8. Coils shall be built in their own full perimeter frame. Tube sheets on each end shall have fully drawn collars to support and protect tubes. Horizontal coil casing and support members shall allow moisture to drain. Casing and support members shall not block finned area.
   9. Individual coils shall be removable from the side of the AHU.
   10. Intermediate drain pan shall be provided on stacked cooling coils. Intermediate drain pan shall slope in a minimum of two planes toward a single drain connection.
   11. A single intermediate vertical coil support shall be provided on coils with a finned length greater than 62.” Two vertical supports shall be provided on coils with a finned length greater than 100,” and three vertical supports on coils with a finned length greater than 141.”
   12. Gap between coil stub out connection and AHU casing, shall be insulated with a spool-shaped sleeve grommet. Adhesive rings applied to the casing walls shall not be acceptable.
14. Water, glycol and DX coils shall be provided with a tube OD of 1/2” or 5/8”. Mechanically expand tubes shall form fin bond and provide burnished, work-hardened interior surface.

15. Water, glycol and steam coil headers shall be made of seamless copper or brass tubing. Pipe connections shall be steel or red brass. Header connections (tubes and piping connections) shall be silver-brazed or TIG welded.

16. Continuous aluminum or copper fins shall be provided for coils with die-formed fins. Fins shall have fully drawn collars to accurately space fins and protect tubes. Fins shall be 0.006” or 0.008 or 0.01” thick.

17. Coil coatings shall be provided as scheduled or indicated on drawings.

2.19 PRIMARY DRAIN PANS

A. Unit(s) shall be provided with a drain pans under each cooling coil.

B. Provide drain pan under the complete width and length of cooling coil sections. Drain pan shall be full width, and extend a minimum of 6” downstream of cooling coil.

C. Drain pans for cooling coils shall meet the requirements of ASHRAE 62.

D. Drain connection shall be made of same material as drain pan. Dissimilar metals shall not be used to mitigate risk of galvanic corrosion. Drain connection shall be welded to the drain pan.

E. Drain pan shall be double wall with an insulation R-value of 6.25 hr-ft2-°F/ (BTU-in).

F. Drain pan shall have minimum of 2” of injected polyurethane foam insulation under the entire bottom surface of the drain pan. Drain pan shall be foam injected as a complete assembly and shall include thermal breaks at connection points to unit casing. Foam insulation shall be manufactured by EcoMate®.

G. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.

H. Provide a minimum of 1” clearance between the drain pan and any coil casing, coil support or any other obstruction.

I. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

J. Provide drain pan sloped in at least two planes by at least 1/8” per foot toward a single drain. Locate drain connection at the lowest point of the pan. Pan shall have no horizontal surfaces.

2.20 PIPE CHASE CABINET

A. Provide pipe chases with double wall, insulated panels. Pipe chase shall have the same thermal performance as the unit casing.

B. Provide a perimeter base rail and/or roof curb under the pipe chase[s] that meets requirements for the AHU base rail and/or roof curb.

C. Manufacturer may combine the pipe chase enclosures of adjacent segments.

D. Provide a minimum pipe chase depth, as shown on drawings. Pipe chase depth is the clear inside dimension from inner pipe chase surface to outer unit surface.
E. In case, pipe chases shipped separate from AHU, manufacturer shall provide chases with lifting lugs for field installation per the AHU base rail requirements ‘if required’.

F. Manufacturer shall provide step-by-step instructions with illustrations for proper pipe chase installation.

2.21 SERVICE VESTIBULE

A. Service vestibule shall extend the full-length of the main unit.

B. Service vestibule shall be integral to unit housing and shall not be a separate section for factory or field attachment.

C. Service vestibule shall have continuous roof system as an integral part of unit housing and shall conform to requirements outlined in “ROOF SYSTEM” section.

2.22 ROOF CURBS

A. Provide factory-fabricated galvanized steel roof curb. Roof curb shall support the full-perimeter of the air handling equipment, including pipe chases.

B. Curb shall be welded, one piece with bolt on pipe chase.

C. Curb shall be constructed of galvanized 14ga exterior, 18ga interior and insulated with 1”x1.5# density insulation, supplied with 1-1/2”x1/4” closed cell neoprene gasket.

D. Match roof curb to roof slope. Curb surface shall be level in both axes.

E. Provide wood nailing strip to which roofer may nail roof flashing.

F. Provide field extension as required to connect to unit openings.

G. Ship roof curb loose for field installation prior to unit placement.

H. Provide curb adapters provided by Curb Technologies, Inc. as required to adapt the new equipment to the existing roof curb and openings.

2.23 FANS

A. GENERAL DESCRIPTION

1. Unit[s] shall be provided with fans as shown on equipment schedule and drawings.

2. The fan section shall be provided with an access door on the drive side of the fan.

3. Fans shall be provided with the following safety accessories:
   a. Fan inlet screens in the inlets of fan housing

4. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame. Manufacturers not complying with this requirement must submit detailed structural and weight data to a licensed structural engineer for review and stamped certification. The mechanical engineer shall review these engineers’ final reports prior to submittal approval.
5. Provide vibration isolation, as scheduled.

6. DWDI fans shall be connected to the unit casing or bulkheads with canvas flexible connection.

7. Provide horizontal thrust restraints between AHU casing and fan housings with end discharge. This requirement applies to the following cases:
   a. SWSI fans operating at greater than 3” of total static pressure
   b. DWDI airfoil fans operating at greater than 6” of total static pressure

8. Bearings shall be offered either with sealed bearings (permanent lubrication).

9. Piezometer Ring: Airflow station shall be factory installed at fan inlet. The device shall have a measurement accuracy of ± 5%. Tubing shall be field-installed.

B. BEARINGS AND DRIVES

1. Unit[s] fans shall be provided with bearings complying with ANSI/AFBMA 9 for fatigue life ratings and with an average life L10 of at least 200,000 hours, as scheduled.

2. Forward curved fans smaller than 18” shall be provided with permanently lubricated bearings. For other fans, manufacturer shall provide re-greaseable bearings with hydraulic grease fittings and lube lines extended to the motor side of the fan or to the exterior of the unit [primary access side].

3. Fans shall be provided drives selected with a 1.5 service factor. Sheaves shall be machined from a close grain cast iron and statically balanced by the manufacturer.

4. Fixed pitch sheaves shall be provided on both the fan and motor. Fans with motors rated at 15 HP or less may be field balanced using variable pitch sheaves. Fixed pitch sheaves shall be provided when final balance is complete. Air balancer shall select and provide final set of sheaves.

5. For Belt-driven fans with 10 HP motors or greater shall be provided with multiple belt drives. Belts shall be V-type, precision molded, raw edge construction, anti-static, oil- and heat-resistant.

C. Direct-Drive Fans (Single or Dual)

1. Plenum (SWSI) Fan
   a. Plenum fan wheel shall be single-width, single-inlet, with 9 or 12 [9, 12] blades.
   b. Plenum fan blades shall be aluminum backward-inclined airfoil.
   c. Plenum fan shall be direct-driven.

2.24 BEARINGS AND DRIVES

A. Fan bearings shall have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings shall comply with ANSI/AFBMA 9.
B. DWDI fans shall be belt-driven. SWSI fans shall be belt driven or direct driven, as shown on product drawings.

C. Re-greaseable fan bearings shall be factory lubricated and equipped with standard hydraulic grease fittings [and lube lines extended to the motor side of the fan]. Fan drives shall be selected for a 1.5 service factor and shall be furnished with anti-static belts.
   1. Drives 15 hp or smaller on constant volume fans shall be adjustable pitch.
   2. Drives 20 hp or larger or drives on fans with VFDs shall be fixed pitch.
   3. Sheaves shall be machined from close grain cast iron and statically balanced.
   4. Drive belts shall be V type, precision molded, raw edge construction, anti-static, oil and heat resistant.

2.25 ELECTRICAL MOTORS

A. Fan motors shall be built in accordance and comply with the latest standards of the NEMA and IEEE.

B. AHU and fan motors shall comply with ASHRAE 90.1.

C. Fan motors shall be provided with the following characteristics:
   1. Voltage, Frequency and Phase, as scheduled.
   2. Motor RPM, as scheduled
   3. Minimum service factor of 1.15
   4. Premium efficiency, or as required to meet ASHRAE 90.1
   5. NEMA design ball bearing type
   6. Rated for continuous duty at full load in a 104°F [40°C] ambient
   7. Open drip proof (ODP) or totally enclosed, fan cooled (TEFC) as scheduled.
   8. Suitable for use in variable frequency application, per NEMA MG-1 Part 30
   9. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2
   10. Grounded drive shafts

2.26 FAN-MOTOR DISCONNECTS

A. Manufacturer shall provide UL or ETL listed fan-motor disconnects and associated components, as scheduled and shown on drawings. Disconnects shall comply with applicable provisions of the National Electric Code.

B. Fused or non-fused fan-motor disconnects shall be provided in NEMA 1, NEMA 3R, NEMA 4, NEMA 12 enclosures, as scheduled or as shown on drawings.
C. Disconnects shall be mounted on the primary access side of the associated fan segment. Where necessary, unit main disconnect shall be mounted [on units with single point power] on the primary access side of supply fan section.

D. Disconnect shall be suitable for use as an OSHA lockout/tagout disconnect when applied in accordance with part IV, Department of Labor OSHA 29 CFR Part 1910, Control of Hazardous Energy Source (lockout/tagout): final rule.

E. Disconnect handles shall be lockable in the “off” position with up to three padlocks. Switch mechanism shall be directly lockable in the “off” position via padlock when door is open.

F. Disconnects shall be provided with integral ground lug.
   1. Provide two (2) #14 ground wires on 16A to 100A disconnects.
   2. Provide one (1) #6-250 ground wire on 200A to 400A disconnects.

G. Auxiliary contacts shall be provided as scheduled.

2.27 FAN-MOTOR VARIABLE FREQUENCY DRIVES (VFDS)

A. Manufacturer shall provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code.

B. VFDs shall be mounted in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings.

C. Outdoor VFDs shall be enclosed in a NEMA 3R enclosure.

D. VFDs on outdoor units shall be suitable for use in ambient temperatures from 5°F to 104°F:
   1. Provide low ambient temperature kit suitable for use down to -20°F.
   2. Provide high ambient temperature kit suitable for use up to 135°F.

E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician. Refer to Section 3.05.

F. Unit(s) shall be provided with following VFD disconnect and bypass optional:
   1. Non-Fused, Fused main disconnect
   2. 2 contactor VFD bypass with VFD service input switch and Non-Fused, Fused main disconnect

G. Unit(s) shall be provided with harmonic distortion feedback protection:
   1. Equivalent 5% impedance input line reactor
   2. Integral RFI/EMI filtering to meet EMC EN61800-3 for First Environment

H. Unit(s) shall be provided with a user interface consisting of following features:
   1. 30 Character multi-lingual alphanumerics display
2. Parameter set-up and operating data

3. Display data shall include:
   a. output frequency (Hz)
   b. speed (RPM)
   c. motor current
   d. calculated % motor torque
   e. calculated motor power (kW)
   f. DC bus voltage
   g. output voltage
   h. heat sink temperature
   i. elapsed time meter (re-settable)
   j. kWh (re-settable)
   k. input / output terminal monitor
   l. PID actual value (feedback) & error
   m. fault text
   n. warning text
   o. scalable process variable display

I. VFD shall be provided with the following protection circuits:
   1. over current
   2. ground fault
   3. over voltage
   4. under voltage
   5. over temperature
   6. input power loss of phase
   7. loss of reference/feedback
   8. adjustable current limit regulator

J. VFD shall be UL 508C approved for electronic motor overload (12t).

K. VFD shall be provided with features for high input transient protection and surge suppression, such as
   1. 4 MOVs ahead of diode bridge
2. 120 Joule rated 1600V diode module
3. Compliant with UL 1449 / ANSI 61.4

L. VFD shall be provided with the following communication features:
1. Two programmable analog inputs
2. Six programmable digital inputs
3. Two programmable analog output
4. Three programmable digital relay outputs
5. Modbus RTU Communications protocol
6. Adjustable filters on analog inputs and outputs
7. Input speed signals, including 4-20 mA and 0-10 VDC
8. Accel/Decel contacts [floating point control]
9. Auto restart [customer selectable and adjustable]
10. Start/Stop options shall include 2 wire dry contact closure, application of input power, and application of reference signal (PID sleep/wake-up).
11. Integrated control interface for Siemens FLN, Johnson N2, Modbus RTU, BACnet MS/TP or LONWorks over RS-485.

M. VFD shall consist of the following functions:
1. Pre-magnetization on start
2. DC braking/hold at stop
3. Ramp or coast to stop
4. Seven preset speeds
5. Three critical frequency lockout bands
6. Start function shall include ramp, flying start, automatic torque boost, and automatic torque boost with flying start

2.28 FACTORY INSTALLED ELECTRICAL ACCESSORIES

A. In addition to motor power terminals, unit(s) shall be provided with an independent power terminal for convenience receptacles and lights.
B. All switches shall be provided as shown on drawings.
C. Unit[s] shall be provided with LED (light emitting diode) lights in segments as scheduled or shown on drawings.
D. On supply fan segment 120V convenience receptacle shall be provided.
2.29 FILTERS

A. Unit[s] shall be provided with filter segments consisting of filters and frames as scheduled.

B. Side or front loading filters for filter segments located upstream of coil segment(s) shall be provided with an access door on the drive side through which filters can be easily loaded.

C. Segments located downstream of coil segment(s) shall be provided with face loading filters. Access plenum and access door of 18” [minimum] shall be provided on the drive side through which face loading filters can be easily loaded.

D. Class 2 or Class 1 filter media shall be provided per U.L. 900 and as required by local codes.

E. Filter types, efficiencies, and nominal depths shall be as follows:
   1. Flat filters – 2” 30% pleated filters.
   2. Rigid filters – 4” mini pleated, MERV 13

F. A pre-filter rack shall be provided in rigid filter segments.

G. Performance of installed filtration system shall be certified via a DOP test and classified as UL Class 1 when tested in accordance with UL Standard 586.

H. Flush mounted, factory installed differential pressure gage on the drive side of unit shall be provided to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

2.30 DAMPERS

A. Dampers provided shall be tested in accordance with AMCA 500.

B. Factory-installed dampers shall be provided, as shown on drawings.

C. Dampers shall have airfoil blades, extruded vinyl edge seals, and flexible metal compressible jamb seals.

D. Dampers shall have a maximum leakage rate of 4 CFM/square foot at 1” w.g., and shall comply with ASHRAE 90.1.

E. Damper blades shall be parallel acting unless otherwise indicated.

F. Damper blades shall be galvanized steel or aluminum, as scheduled.

2.31 UVC FIXTURES

A. Fixtures have been tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.

B. Fixtures meet the “UL” drip proof design and each fixture is equipped with an electrical interlock.

C. Each lamp contains no more than 5.5 milligrams of mercury consistent with current environmental practices while producing the specified output at 500 fpm in temperatures of 55-135° F.
D. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and shall not produce ozone.

E. Refer to Section 230566.

2.32 AIRFLOW MONITORING STATIONS

A. Optional airflow monitoring stations shall be provided on air inlets, as shown in performance specifications.

B. Airflow monitoring stations shall bear the AMCA Certified Ratings Seal for Airflow Measurement Performance.

C. Airflow monitoring station dampers shall comply with leakage rates per ASHRAE 90.1.

D. Airflow monitoring stations shall be accurate within 5% of actual airflow between 300 FPM and 3000 FPM free area velocity.

E. Factory installed transducer that sends a CFM-proportional, 4-20 mA or 0-10V signal shall be provided only when factory packaged controls option is selected.

2.33 APPURTENANCES

A. Rain hoods shall be provided on outdoor unit air intakes, as shown on drawings. Moisture screens shall be provided on outdoor air inlet rain hoods.

B. Steel, [structural formed or welded] base rails suitable for rigging and lifting shall be provided, as shown on product drawings.

C. Safety grates over bottom openings shall be provided, as shown on drawings. Safety grates shall be capable of supporting a 300 lb. center load.

D. Lifting lugs shall be provided where required.

2.34 EXTERIOR FINISHES

A. Manufacturer shall clean the exterior surfaces of units prior to application of exterior protective coating.

B. Manufacturer shall paint exterior surfaces of outdoor units prior to shipment.
   1. Manufacturer shall apply a primer prior to application of finish coating.
   2. Exterior finish coating shall show a breakdown of less than 1/8” on either side of a scribed line when subjected to ASTM B117 2,000 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of ‘6.’ Also, per ASTM D610, degree of rusting to meet #8-G and per ASTM D714 degree of blister to meet #6 medium.

2.35 LIGHTS AND OUTLETS

A. Lights
   1. Factory shall provide vapor resistant, marine type LED lighting fixture located in segments and quantity as indicated on the drawings.
2. Factory shall wire all light fixtures to a common 120v switch located on the supply fan segment.

3. External light switches shall be provided with a 1-hour timer.

B. Outlets

1. Factory shall provide a 2015A GFI duplex outlet mounted in a weatherproof enclosure in segments and quantity as indicated on the drawings. Refer to the electrical drawings.

**PART 3 EXECUTION**

3.1 INSTALLATION OF CURB ADAPTOR

A. Remove existing units from existing curb and inspect existing curb for damage or excessive wear. Report any findings to the owner.

B. Remove all original gasket material.

C. Reinforce existing curb and/or roof structure as required by unit manufacturer.

D. Provide caulking to top of existing curb and secure new adaptor to the existing curb per manufacturer requirements.

E. Align supply air opening and install blank off panels as required.

F. Apply gasket material between curb adaptor and new unit.

3.2 INSTALLATION

A. Install equipment per industry standards, applicable codes, and manufacturer’s instructions.

B. AHUs shall not be used for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.

C. Install AHUs on a roof curb and curb adaptor as shown on drawings.

D. Install AHUs with manufacturer’s recommended clearances for access, coil pull, and fan removal.

E. One complete set of filters shall be provided for testing, balancing, and commissioning. Provide additional complete sets of filters at time of transfer to owner. Refer to Section 230500.

F. Install AHU plumb and level. Connect piping and ductwork according to manufacturer’s instructions.

G. Install pipe chases per manufacturer’s instructions.

H. Insulate plumbing associated with drain pan drains and connections.

I. Install insulation on all staggered coil piping connections, both internal and external to the unit.

3.3 FIELD QUALITY CONTROL

A. AHU shall be stored as per manufacturer’s written recommendations.
B. AHUs shall be stored indoors in a warm, clean, dry place where unit(s) will be protected from weather, construction traffic, dirt, dust, water and moisture. If unit(s) to be stored for more than 6 months, manufacturer’s instruction for long-term storage shall be followed.

C. Rig and lift units shall be according manufacturer’s instructions.

3.4 AHU INSPECTION

A. Hire manufacturer’s factory-trained and factory-employed service technician to perform an inspection of unit and installation prior to startup. Technician shall inspect and verify the following as a minimum:
   1. Damage of any kind
   2. Level installation of unit
   3. Proper reassembly and sealing of unit segments at shipping splits.
   4. Tight seal around perimeter of unit at the roof curb
   5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
   6. Completion and tightness of electrical, ductwork and piping
   7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
   8. Supply of electricity from the building’s permanent source
   9. Integrity of condensate trap for positive or negative pressure operation
   10. Condensate traps charged with water
   11. Removal of shipping bolts and shipping restraints
   12. Sealing of pipe chase floor(s) at penetration locations.
   13. Tightness and full motion range of damper linkages operate manually
   14. Complete installation of control system including end devices and wiring
   15. Cleanliness of AHU interior and connecting ductwork
   16. Proper service and access clearances
   17. Proper installation of filters
   18. Filter gauge set to zero

B. Resolve any non-compliant items prior to unit start-up.

3.5 INSPECTION AND ADJUSTMENT: AHU FAN ASSEMBLY

A. Hire the manufacturer’s factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:
1. Fan isolation base and thrust restraint alignment  
2. Tight set screws on pulleys, bearings and fan  
3. Tight fan bearing bolts  
4. Tight fan and motor sheaves  
5. Tight motor base and mounting bolts  
6. Blower wheel tight and aligned to fan shaft  
7. Sheave alignment and belt tension  
8. Fan discharge alignment with discharge opening  
9. Fan bearing lubrication  
10. Free rotation of moving components rotate manually

B. Manufacturer shall dynamically balance fan/motor/base assembly.  
   1. Balance constant volume fan assemblies at design RPM.  
   2. Balance variable volume fan assemblies from 10% to 100% of design RPM.  
   3. Take filter-in measurements in the horizontal and vertical axes on the drive and opposite-drive sides of fan shafts.  
   5. Variable speed fan vibration limits: filter-in measurements shall not exceed 7 mils. 

C. Manufacturer shall hi-pot test wiring intended to carry voltages greater than 30VAC.

3.6 Startup Service and Owner Training

A. Manufacturer’s factory-trained and factory-employed service technician shall startup AHUs. Technician shall perform the following steps as a minimum:
   1. Energize the unit disconnect switch  
   2. Verify correct voltage, phases and cycles  
   4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.  
   5. Energize fan motors and verify that motor FLA is within manufacturer’s tolerance of nameplate FLA for each phase. 

B. Provide a minimum of 4 hours of training for owner’s personnel by manufacturer’s factory-trained and factory-employed service technician. Training shall include AHU controls, motor starter, VFD, and AHU.
C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

D. If AHU is provided with a factory-mounted variable frequency drive (VFD), hire the VFD manufacturer’s factory-trained and factory-employed service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as ‘skip frequencies’ in the VFD controller.

E. Submit a startup report summarizing any problems found and remedies performed.

3.7 CLEANING

A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.

B. Clean exterior prior to transfer to owner.

3.8 DOCUMENTATION

A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.

B. Provide six copies of Spare Parts Manual for owner’s project system manual.
HVAC ALTERNATE BID

1. **Add Alternate Bid H-1:** State an amount in dollars to be added to the Base Bid to replace all existing pneumatic controlled VAV terminals. The new VAV terminals will be electronically controlled and connected and integrated with the existing building ATC system. The contractor is required to modify the existing duct and piping as required to install the new VAV terminals. Integration of the new VAV terminals will require extension of the existing ATC wiring infrastructure to each new VAV. This Alternate Bid is to include removal and proper disposal of the existing VAV and any piping and ductwork required to accommodate the installation.

END OF SECTION